

# Bothalia

A JOURNAL OF BOTANICAL RESEARCH

Vol. 31,2

Oct. 2001

## TECHNICAL PUBLICATIONS OF THE NATIONAL BOTANICAL INSTITUTE, PRETORIA

Obtainable from the National Botanical Institute, Private Bag X101, Pretoria 0001, Republic of South Africa. A catalogue of all available publications will be issued on request.

### BOTHALIA

*Bothalia* is named in honour of General Louis Botha, first Premier and Minister of Agriculture of the Union of South Africa. This house journal of the National Botanical Institute, Pretoria, is devoted to the furtherance of botanical science. The main fields covered are taxonomy, ecology, anatomy and cytology. Two parts of the journal and an index to contents, authors and subjects are published annually.

Three booklets of the contents (a) to Vols 1–20, (b) to Vols 21–25 and (c) to Vols 26–30, are available.

### STRELITZIA

A series of occasional publications on southern African flora and vegetation, replacing *Memoirs of the Botanical Survey of South Africa* and *Annals of Kirstenbosch Botanic Gardens*.

### MEMOIRS OF THE BOTANICAL SURVEY OF SOUTH AFRICA

The memoirs are individual treatises usually of an ecological nature, but sometimes dealing with taxonomy or economic botany. Published: Nos 1–63 (many out of print). Discontinued after No. 63.

### ANNALS OF KIRSTENBOSCH BOTANIC GARDENS

A series devoted to the publication of monographs and major works on southern African flora. Published: Vols 14–19 (earlier volumes published as Supplementary volumes to the *Journal of South African Botany*). Discontinued after Vol. 19.

### FLOWERING PLANTS OF AFRICA (FPA)

This serial presents colour plates of African plants with accompanying text. The plates are prepared mainly by the artists at the National Botanical Institute. Many botanical artists have contributed to the series, such as Fay Anderson, Peter Bally, Auriol Batten, Gillian Condry, Betty Connell, Stella Gower, Rosemary Holcroft, Kathleen Lansdell, Cythna Letty (over 700 plates), Claire Linder-Smith and Ellaphie Ward-Hilhorst. The Editor is pleased to receive living plants of general interest or of economic value for illustration.

From Vol. 55, twenty plates are published at irregular intervals.

An index to Vols 1–49 is available.

### FLORA OF SOUTHERN AFRICA (FSA)

A taxonomic treatise on the flora of the Republic of South Africa, Lesotho, Swaziland, Namibia and Botswana. The *FSA* contains descriptions of families, genera, species, infraspecific taxa, keys to genera and species, synonymy, literature and limited specimen citations, as well as taxonomic and ecological notes.

Contributions to the *FSA* also appear in *Bothalia*.

### PALAEOFLORA OF SOUTHERN AFRICA

A palaeoflora on a pattern comparable to that of the *Flora of southern Africa*. Much of the information is presented in the form of tables and photographic plates depicting fossil populations. Now available:

Molteno Formation (Triassic) Vol. 1. Introduction. *Dicroidium*, 1983, by J.M. & H.M. Anderson.

Molteno Formation (Triassic) Vol. 2. Gymnosperms (excluding *Dicroidium*), 1989, by J.M. & H.M. Anderson.

Prodromus of South African Megaflores. Devonian to Lower Cretaceous, 1985, by J.M. & H.M. Anderson. Obtainable from: A.A. Balkema Marketing, Box 317, Claremont 7735, RSA.

Towards Gondwana Alive. Promoting biodiversity and stemming the Sixth Extinction, 1999, by J.M. Anderson (ed.)

# BOTHALIA

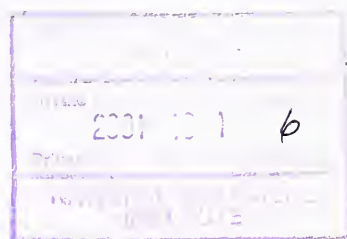
A JOURNAL OF BOTANICAL RESEARCH

**Volume 31,2**

Scientific Editor: G. Germishuizen  
Technical Editor: B.A. Momberg



NATIONAL  
*B*OTANICAL  
INSTITUTE



2 Cussonia Avenue, Brummeria, Pretoria  
Private Bag X101, Pretoria 0001

ISSN 0006 8241

October 2001

### Editorial Board

<b>D.F. Cutler</b>	Royal Botanic Gardens, Kew, UK
<b>B.J. Huntley</b>	National Botanical Institute, Cape Town, RSA
<b>P.H. Raven</b>	Missouri Botanical Garden, St Louis, USA
<b>J.P. Rourke</b>	Compton Herbarium, NBI, Cape Town, RSA
<b>M.J. Werger</b>	University of Utrecht, Utrecht, Netherlands

### Acknowledgements to referees

Archer, Mrs C. National Botanical Institute, Pretoria, RSA.  
Balkwill, Prof. K. University of the Witwatersrand, Johannesburg, RSA.  
Beyers, Dr J.B.P. National Botanical Institute, Cape Town, RSA.  
Braggins, Dr J. Auckland, New Zealand.  
Bredenkamp, Mrs C.L. National Botanical Institute, Pretoria, RSA.  
Bremer, Prof. K. University of Uppsala, Uppsala, Sweden.  
Brown, Dr E. Royal Botanic Gardens, Sydney, Australia.  
Brownsey, Dr P.J. Herbarium, National Museum, Wellington, New Zealand.  
Cutler, Dr D.F. Royal Botanic Gardens, Kew, UK.  
De Paiva, Dr J.A.R. University of Coimbra, Coimbra, Portugal.  
Farjon, Dr A. Royal Botanic Gardens, Kew, UK.  
Furuki, Dr T. Natural History Museum & Institute, Chiba, Japan.  
Geerinck, Dr D. National Botanical Garden, Meise, Belgium.  
Henderson, Ms L. Agricultural Research Council, Pretoria, RSA.  
Hill, Dr K.D. National Herbarium of New South Wales, Sydney, Australia.  
Jordaan, Ms M. National Botanical Institute, Pretoria, RSA.  
Jovet-Ast, Dr S. Biarritz, France.  
Kativu, S. National Herbarium, Harare, Zimbabwe.  
Leistner, Dr O.A. National Botanical Institute, Pretoria, RSA.  
Manning, Dr J.C. National Botanical Institute, Cape Town, RSA.  
Moll, Prof. E.J. SAWC, Hoedspruit, RSA.  
Nelson, Dr E.C. Outwell, Wisbech, UK.  
Nevling, Dr L.I. Illinois Natural History Survey, USA.  
Newton, Prof. L.E. Kenyatta University, Nairobi, Kenya.  
Nordenstam, Prof. R.B. Natural History Museum, Stockholm, Sweden.  
Parris, Dr B. Fern Research Foundation, Bay of Islands, New Zealand.  
Patterson-Jones, Dr D. National Botanical Institute, Cape Town, RSA.  
Pócs, Prof. T. Eszterházy College, Eger, Hungary.  
Retief, Ms E. National Botanical Institute, Pretoria, RSA.  
Rourke, Dr J.P. National Botanical Institute, Cape Town, RSA.  
Roux, Dr J.P. National Botanical Institute, Cape Town.  
Schrire, Dr B. Royal Botanic Gardens, Kew, UK.  
Schutte-Vlok, Ms A. Oudtshoorn, RSA.  
Weberling, Prof. Dr F. University of Ulm, Germany.  
Welman, Ms W.G. National Botanical Institute, Pretoria, RSA.



# CONTENTS

Volume 31,2

1. Studies in the genus <i>Riccia</i> (Marchantiales) from southern Africa. 25. A new species in subgenus <i>Ricciella</i> , section <i>Ricciella</i> . S.M. PEROLD	151
2. Five new species of <i>Erica</i> (Ericaceae) from the Swartberg Range, Western Cape, South Africa and a note on <i>E. esterhuyseniae</i> . E.G.H. OLIVER and I.M. OLIVER	155
3. Studies in the liverwort family Aneuraceae (Metzgeriales) from southern Africa. 1. The genus <i>Aneura</i> and its local representative. S.M. PEROLD	167
4. Three new species of <i>Tritoniopsis</i> (Iridaceae: Crocoideae) from the Cape Region of South Africa J.C. MANNING and P. GOLDBLATT	175
5. Studies in the liverwort family Aneuraceae (Metzgeriales) from southern Africa. 2. The genus <i>Riccardia</i> and its type species, <i>R. multifida</i> , with confirmation of its presence in the region. S.M. PEROLD	183
6. Notes on African plants:	
Acanthaceae, Thymelaeaceae, Lamiaceae. New records and distributional disjunctions from South Africa, Zimbabwe and Mozambique. T.J. EDWARDS, A.J. BEAUMONT and D. STYLES	199
Colchicaceae. A remarkable new species of <i>Androcymbium</i> from Northern Cape, South Africa. J.C. MANNING and P. GOLDBLATT	203
Dennstaedtiaceae–Pteropsida. <i>Hypolepis villosa-viscida</i> new to the <i>Flora of southern Africa</i> . J.P. ROUX	195
Fabaceae. The identity of <i>Melolobium lampolobium</i> (Papilionoideae) A. MOTEETEE and B-E. VAN WYK	209
Gentianaceae. A new species of <i>Sebaea</i> from the Swartberg Range, Western Cape, South Africa. I.M. OLIVER and J.B.P. BEYERS	207
Hyacinthaceae. The generic delimitation within Hyacinthaceae, a comment on works by F. Speta. B. STEDJE	192
Iridaceae. Two new renosterveld species of Crocoideae from South Africa. J.C. MANNING and P. GOLDBLATT	189
Portulacaceae. <i>Talinum paniculatum</i> , a naturalized weed in South Africa. E.M.A. STEYN and G.F. SMITH	195
Pteridophyta. New distribution records of southern African Pteridophyta. J.E. BURROWS and S.M. BURROWS	205
Zamiaceae. <i>Encephalartos relictus</i> : a new species from southern Africa. P.J.H. HURTER and H.F. GLEN	197
7. Taxonomic significance of inflorescences, floral morphology and anatomy in <i>Passerina</i> (Thymelaeaceae). C.L. BREDENKAMP and A.E. VAN WYK	213
8. Miscellaneous notes:	
Aloaceae. Are ovules and seeds in <i>Lomatophyllum</i> Willd. ( <i>Aloe</i> sect. <i>Lomatophyllum sensu auct.</i> ) anatropous and exarillate? E.M.A. STEYN and G.F. SMITH	237
9. Obituary: Heinrich Johann Wilhelm Giess (1910–2000). HERTA KOLBERG	241
10. Book review	245
11. National Botanical Institute South Africa: administration and research staff, 31 March 2001, publications 1 April 2000–31 March 2001. Compiler: B.A. Momberg	247
12. Guide for authors to <i>Bothalia</i>	265

## New species, subspecies and combinations in *Bothalia* 31,2 (2001)

- Androcymbium asteroides* J.C.Manning & Goldblatt, sp. nov., 203  
*Encephalartos relictus* P.J.H.Hurter, sp. nov., 197  
*Erica blaerioides* E.G.H.Oliv., sp. nov., 163  
*Erica blaerioides* subsp. *hirsuta* E.G.H.Oliv., subsp. nov., 165  
*Erica chionodes* E.G.H.Oliv., sp. nov., 161  
*Erica dolfiana* E.G.H.Oliv., sp. nov., 155  
*Erica oreotragus* E.G.H.Oliv., sp. nov., 160  
*Erica taylorii* E.G.H.Oliv., sp. nov., 157  
*Freesia fucata* J.C.Manning & Goldblatt, sp. nov., 189  
*Ixia atrandra* Goldblatt & J.C. Manning, sp. nov., 191  
*Melolobium lampolobum* (E.Mey.) A.Moteetee & B-E.van Wyk, comb. nov., 210  
*Riccia sibayenii* Perold, sp. nov., 151  
*Sebaea amicorum* I.M.Oliv. & Beyers, sp. nov., 207  
*Tritoniopsis bicolor* J.C.Manning & Goldblatt, sp. nov., 175  
*Tritoniopsis flava* J.C.Manning & Goldblatt, sp. nov., 178  
*Tritoniopsis toximontana* J.C.Manning & Goldblatt, sp. nov., 178

## Studies in the genus *Riccia* (Marchantiales) from southern Africa. 25. A new species in subgenus *Ricciella*, section *Ricciella*

S.M. PEROLD\*

**Keywords:** Marchantiales, *Riccia sibayenii* Perold, section *Ricciella* (A.Br.) Bisch., subgenus *Ricciella*, southern Africa

### ABSTRACT

*Riccia sibayenii* Perold is a new species, recently collected in Mpumalanga, near Sibayeni and has been named for this town, which is close to the Mozambique border and is in the summer rainfall area. *R. sibayenii* is distinguished by lime-green, medium-sized to quite large thalli with a chlorophyllose dorsal epidermis, air pores that soon enlarge and lead into mostly 6-sided air chambers below; ventrally with a thin median layer of storage tissue; ventral scales absent and the rhizoids all smooth. The spores are winged and polar, the distal face completely or incompletely reticulate and the proximal face ornamented with fine to coarse, sometimes spinose granules.

### *Riccia sibayenii* Perold, sp. nov.

Thalli dioici, annui, subdense turbati, rosulas non formantes, prasini sine ullo colore purpureo, ramis usque ad 16 vel 17 mm longis, 1.05–3.75 mm latis, oblongis vel apicem versus angustatis. Cavemulae supra poris aperientes, apicem versus parvis, proximaliter maioribus, aetate disintegrantes; tela penaria solum in parte media carinata. 4–6 cellulas profunda. *Squamae ventrales* absentes, rhizoideae omnes glabrae. *Capsulae* exsertae, ventraliter aperientes. *Sporae* 77.5–100.0 µm diametro, triangulari-globosae, atrobrunneae, alis cum duabus seriebus granularum secus marginem, anisopolaes, superficie distali cum alveolis completis vel incompletis, cristis cum duabus seriebus granularum grossarum asperatis; superficie proximali cum nota triradiata prominenti, in quaque superficula cum granulis tenuibus vel grossis dispersis ornata. *Numerus chromosomatum* ignotus.

TYPE.—Mpumalanga, 2531 (Komatipoort): ± 10 km south of Komatipoort, between the Kaftan fence and Komati River, near Sibayeni town, altitude 270 m, on black loamy soil, (–DB), 2000-07-12, *Jean J. Meyer* 2875 (PRE, holo.). Figure 1.

*Thallus* medium-sized to fairly large, annual, quite densely massed in patches, not forming rosettes, sometimes with branches overlying, occasionally covering old thalli from previous season, usually closely adherent to substrate, lime-green, without any purple coloration; branches never simple, mostly twice to several times furcate (Figure 2A), total length up to 16–17 mm long, segments narrowly to moderately divergent, 3–7 × 1.05–3.75 mm, 700–1250 µm thick medianly, thinner toward winged margins, in section 1.5–3 times wider than thick; oblong to tapering toward apex, shortly once or twice emarginate, flat to slightly concave above, not medianly grooved, margins winged, blunt, rather irregularly scalloped, flanks sloping obliquely, ventral face rounded and keeled, giving rise to perennating stolons,

scales absent; when dry, margins sometimes slightly raised, not inflexed.

*Dorsal epidermis* (Figures 2B; 3B) covering air chambers flat, delicate and translucent, cells unistratose, 4–6-sided, 50–80 × 42.5–67.5 µm; air pores distally small (Figure 3A), soon enlarging to 80–125 × 50–75 µm or more in older parts, irregular in shape, bordering cells not differentiated (Figure 3C), breaking down with age and air chambers below becoming exposed. *Assimilation tissue* up to 875 µm thick, occupying most of thickness of thallus, air chambers 12–14 across width of thallus, from above mostly penta- or hexagonal, but in cross section polygonal and variable in size, the enclosing chlorophyllose, unistratose walls with cells 80.0–87.5 × 75–100 µm, vertically to obliquely arranged, here and there intersecting, air chambers then in 2 or 3 layers, except at margins, where only 1 layer deep; storage tissue confined to median keeled part, 4–6 cell layers or 200–250 µm thick, cells dorsiventrally flattened, 50.5–62.5 × 77.5–102.5 µm, sometimes with smaller cells wedged in between. *Ventral scales* absent. *Rhizoids* all smooth, 15–35 µm wide.

Dioicous. *Antheridia* serially arranged in 2 or 3 rows (Figure 3D) and submerged along middle of thallus

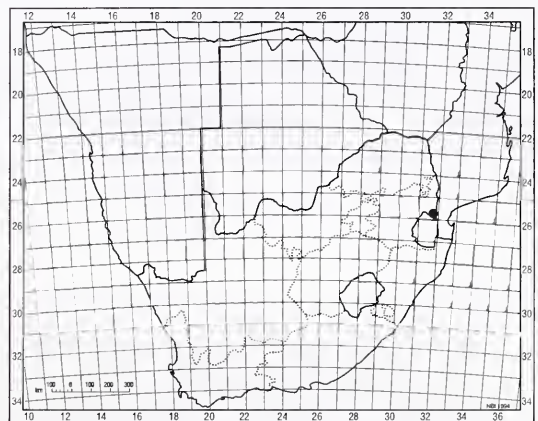


FIGURE 1.—Locality of *Riccia sibayenii* in southern Africa.

\* National Botanical Institute, Private Bag X101, 0001 Pretoria.  
MS. received: 2001-03-02.

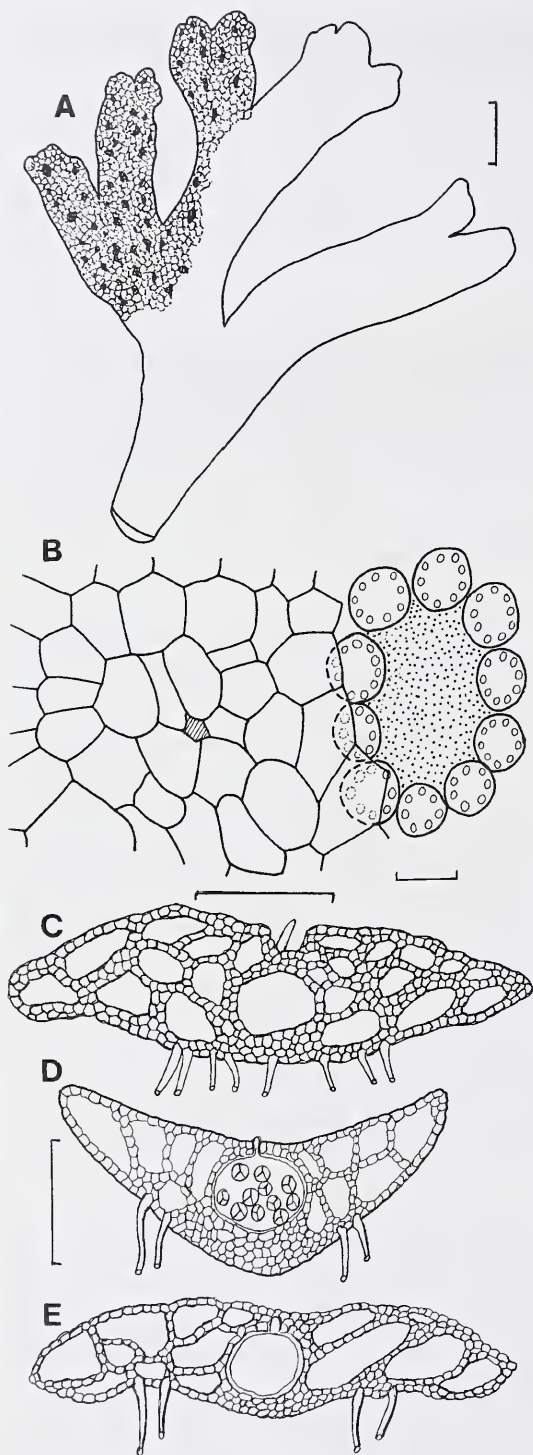


FIGURE 2.—*Riccia sibayenii*. A, plant with several branches; B, epidermal cells and air pore (hatched) overlying one air chamber, the other partly exposed, as seen from above; C, c/s male branch through air chambers and antheridial cavity; D, c/s near apex of female branch with air chambers and capsule; E, c/s nearer to base of female branch with air chambers and capsule. A–E, J.J. Meyer 2875. Scale bars: A, 2 mm; B, 50 μm; C–E, 1 mm.

(Figure 2C), cavities  $330\text{--}350 \times 310\text{--}410\text{ }\mu\text{m}$ , necks arising above from small hollows and projecting up to  $230\text{ }\mu\text{m}$  above thallus. *Archegonia* arranged in a row along middle of segments, sometimes obliquely orientated, necks  $\pm 160\text{ }\mu\text{m}$  long (Figure 3F), dark red. *Capsules* protruding and opening ventrally (Figure 2D, E), up to 6 in an acropetal row along branch,  $450\text{--}575\text{ }\mu\text{m}$  diam., hardly visible from above (Figure 3E), containing up to  $\pm 350$  spores each, those in the youngest capsule near apex sometimes still immature. *Spores*  $77.5\text{--}100.0\text{ }\mu\text{m}$  diam., triangular-globular, anisopolar, dark brown, semi-transparent to opaque; wing  $\pm 7.5\text{ }\mu\text{m}$  wide, at marginal angles width  $\pm 10\text{ }\mu\text{m}$  and perforated by single large pore (Figure 4D), margin finely crenulate with 2 rows of granules, one along edge and the other immediately inward; ornamentation on the 2 faces quite different; distal face (Figure 4A–D) completely to incompletely reticulate: with up to  $5 \pm$  complete alveoli,  $12.5\text{--}17.5 \times 12.5\text{--}22.5\text{ }\mu\text{m}$ , across distal face and totalling  $\pm 15$ , otherwise with 3 or 4 larger, central alveoli,  $\pm 25 \times 17.5\text{ }\mu\text{m}$ , surrounded by smaller ones that may be confluent or separated, ridges  $\pm 5\text{ }\mu\text{m}$  high, thick and roughened by 2 rows of granules, coarser than marginal ones, not raised at nodes and not extending across wing; proximal face (Figure 4E, F) with prominent triradial mark  $\pm 2.5\text{ }\mu\text{m}$  high, all or some arms extending across wing, each facet ornamented with scattered, fine to coarse granules, some single and spinose, others joined together. *Chromosome number*: unknown, as material no longer living.

Thallus sections from the dry plants that were soaked up, proved quite difficult to prepare. Hopefully, living plants will still come to hand in the future. So far, the species has only been collected once (Figure 1). It grows on black, loamy soil (pH7) derived from weathered basalt of the Letaba Formation (Lebombo group) of the Karroo Sequence (Visser *et al.* 1984), in full sun on a gentle slope in a valley that becomes waterlogged during the summer months, when most of the rain falls. The vegetation type of vascular plants in the area is Lebombo Arid Mountain Bushveld (Low & Rebelo 1996).

The locality is described as disturbed. As it is close to the Mozambique border, there has been an influx of people fleeing from the war and its aftermath. It is possible that the recent floods in the wake of cyclones Hudah and Eline, may have spread the spores of this species further southward, as it must be more widespread than this single, though quite copious collection suggests. The area is, however, very undercollected as far as bryophytes are concerned, in fact, none have previously been recorded for the quarter degree grid 2531DB.

Although related to *R. rubricollis*, which was collected by Duthie in 1929 at Knysna, this new species differs from it by being more delicate and by totally lacking any purple colouration due to anthocyanin pigmentation on the dorsal surface of the thallus, as well as in the antheridial necks. Furthermore, the spores of *R. sibayenii* have double rows of granules along the wing margins and on the alveolar walls on the distal face. The proximal face is ornamented with spinose granules and not with smooth-walled alveoli, which are present in *R. rubricollis* on both faces (Perold 1991). In addition, *R. sibayenii* grows in the subtropics, which has summer rain, not in



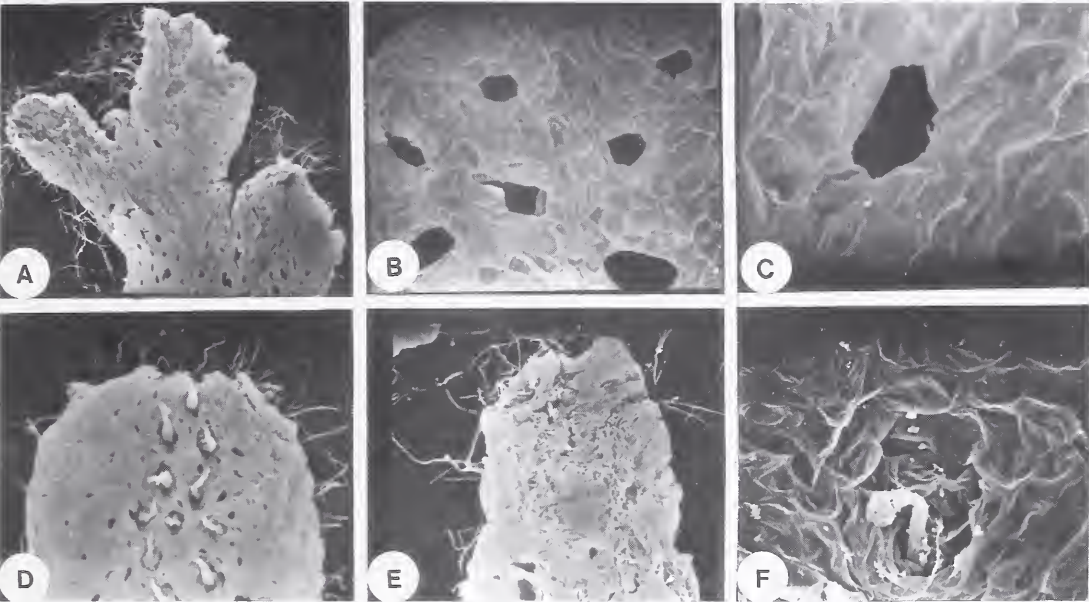


FIGURE 3.—*Riccia sibayenii*. A, distal branches of thallus with air pores gradually increasing in size more proximally; B, pores and dorsal epidermal cells; C, single pore and surrounding dorsal cells; D, 2 or 3 rows of antheridia near apex of male branch; E, toward apex of female branch with capsule only faintly visible from above; F, protruding archegonial neck (no longer erect). A–F, J.J. Meyer 2875. A,  $\times 8.3$ ; B,  $\times 58$ ; C,  $\times 202$ ; D,  $\times 20$ ; E,  $\times 18.4$ ; F,  $\times 133$ .

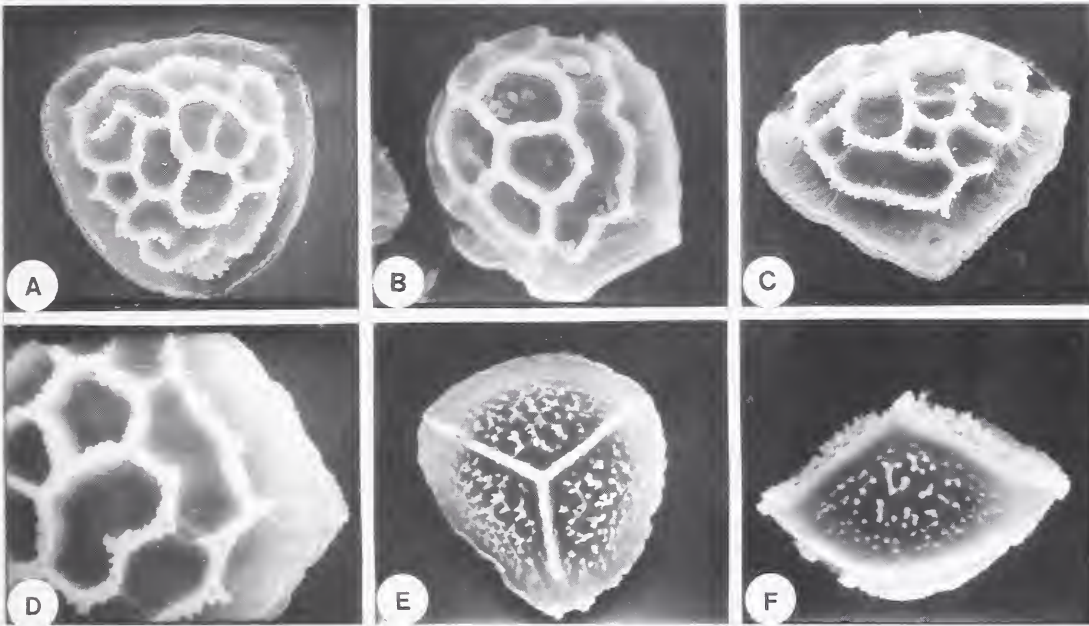


FIGURE 4.—*Riccia sibayenii*. Spores. A–C, distal face: C, side view; D, part of distal face, wing margin and pore; E, proximal face with triradiate mark; F, side view of proximal face. A–F, J.J. Meyer 2875. A,  $\times 418$ ; B,  $\times 500$ ; C,  $\times 514$ ; D,  $\times 661$ ; E,  $\times 403.7$ ; F,  $\times 399$ .

the temperate southern Cape, known for its fynbos and rain almost all year round.

Because its sporangia protrude and open ventrally, *R. sibayenii* is referred to subgenus *Ricciella* (A.Br.) Bisch., section *Ricciella*, together with *R. stricta* and *R. purpurascens*. *R. rubricollis* was referred to subgenus *Ricciella*,

section *Spongodes*, because the sporangia are deeply embedded in the thallus and open dorsally (Perold 1995).

ACKNOWLEDGEMENTS

I wish to sincerely thank Dr S. Jovet-Ast for kindly refereeing this paper, as well as my colleague, Mr J.J. Meyer,



for collecting this new species. Dr H.F. Glen is thanked for translating the diagnosis into Latin. I also extend my gratitude to Ms G. Condry for the drawings, to Mrs A. Romanowski for developing and printing the photographs, and to Ms D. Maree for typing the manuscript.

#### REFERENCES

- LOW, A.B. & REBELO, A.G. 1996. *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs & Tourism, Pretoria.
- PEROLD, S.M. 1991. Studies in the genus *Riccia* (Marchantiales) from southern Africa. 22. *R. rubricollis*, now validated, typified and described. *Bothalia* 21: 51–54.
- PEROLD, S.M. 1995. The taxonomic history of the Ricciaceae (1937–1995) and a classification of sub-Saharan Ricciaceae. *Bothalia* 25: 211–231.
- VISSER, D.J.L. *et al.* 1984. *Geological map of the Republics of South Africa, Transkei, Bophuthatswana, Venda and Ciskei and the Kingdoms of Lesotho and Swaziland*. The Government Printer, Pretoria.

# Five new species of *Erica* (Ericaceae) from the Swartberg Range, Western Cape, South Africa and a note on *E. esterhuyseniae*

E.G.H. OLIVER\* and I.M. OLIVER\*

**Keywords:** *Erica* L., taxonomy, new species, South Africa, Swartberg, Western Cape

## ABSTRACT

Descriptions are provided of five new species of *Erica* L. from the Klein and Groot Swartberg Mountains in Western Cape, South Africa. The two known populations of *E. dolfiana* E.G.H.Oliv. are confined to the stony, southern slopes of two well-separated areas. *E. taylorii* E.G.H.Oliv. is also known from two well-separated populations on the Swartberg but with the others in the Cederberg. The other three new species are allied to *E. esterhuyseniae* Compton: *E. chionodes* E.G.H.Oliv., with brilliant white flowers, occurs only in seepage zones in two well-separated areas, *E. oreotragus* E.G.H.Oliv. (syn. *E. esterhuyseniae* Compton var. *trimera* Compton) with pale pink to white flowers and *E. blaerioides* E.G.H.Oliv. with white flowers, are widespread in the central and western Swartberg Range.

1. *Erica dolfiana* E.G.H.Oliv., sp. nov., in genere affinitate dubia, sed foliis quadrinatis petiolo longo bractea bracteolisque comparate longis plus minusve sepala aequantibus sed remotis, corolla urceolata glabra alba parva, antheris glabris calcaribus longis tenuibus filamentis tenuibus, stigmate subpeltata ad peltata seminibus vulgo ericoideis reticulatis dignoscenda. Figura 1.

TYPE.—Western Cape, 3322 (Oudtshoorn): Oudtshoorn, Groot Swartberg, peak just north of Tierberg, 2 010 m, (–AD), 17 October 2000, E.G.H. & I.M. Oliver 11688 (NBG, holo.; BM, BOL, K, MO, NY, P, PRE, S).

Erect, compact shrub up to 300(–500) mm tall, single-stemmed reseed. *Branches*: main branches up to 50 mm long, erect, with numerous secondary branches 2–5 mm long on every node towards apex and a few sometimes distally, all ending in an inflorescence; all branches with short, spreading to reflexed hairs with or without a few stouter, longer gland-tipped hairs admixed. *Leaves* 4-nate, subspreading, imbricate, ovate to elliptic, 2.0–3.3 × 1.0–1.3 mm, adaxially flattened and abaxially rounded with acute margins, sparsely puberulous with a few long, stouter gland-tipped hairs interspersed abaxially, ciliate with a few long, gland-tipped hairs, sulcus narrow and open at base; petiole ± 1.3 mm long, puberulous. *Inflorescence*: flowers 4-nate in 1 whorl at apex of main and secondary branches, these packed in terminal, capitate or longer spike-like synflorescences; pedicel ± 2.2 mm long, loosely puberulous, white to pale green, sometimes tinged red; bract partially recaulescent from basal to middle position, oblong, ± 1.4 × 0.4 mm, with very short subapical sulcus, white and slightly hyaline, sometimes with pale green tip, sparsely puberulous in upper 1/4–1/2, margins with gland-tipped hairs and one apically, glands white or pink; bracteoles 2, median to just below calyx in position, otherwise like bract. *Calyx* 4-lobed, fused ± 1/8 at base; lobes adpressed to corolla, oblong, ± 2.0 × 0.5 mm, subacute, sulcus in upper half, short and narrow,

white to pale green or reddish, more so at apex, puberulous in upper 1/4–1/2, margins with short gland-tipped hairs, glands red. *Corolla* 4-lobed, campanulate to slightly urceolate, ± 3.4 × 2.2 mm, glabrous, white or tinged pink; lobes ± 0.7 × 1.3 mm, rounded to emarginate, margins entire to slightly erose. *Stamens* 8, included, free; filaments narrowly linear, ± 1.8 mm long, with slight apical S-bend, glabrous, white; anthers bipartite, oblong in adaxial view, dorsally attached near base, appendiculate; thecae erect adpressed, ovate to elliptic in lateral view, ± 0.9 × 0.5 mm, smooth dark brown, spurs narrowly lanceolate, ± 0.6 mm long, with 2 or 3 teeth, white, pore ± 1/3 length of theca; pollen in tetrads. *Ovary* 4-locular, broadly obovoid-ellipsoid, ± 1 × 1 mm, emarginate, puberulous, green, with small dark-green nectaries around base; ovules 9–15 per locule, laterally spreading; style ± 2.7 mm long, exerted, pale greenish red, glabrous; stigma subpeltate to peltate, dark red. *Fruit* a dehiscent capsule, ± 1.1 × 1.5 mm, valves splitting for 3/4 their length and to ± 45° angle, septa equally divided on columella and valves. *Seeds* ellipsoid, ± 0.4 × 0.25 mm, slightly alveolate, orange, testa cells 60–75 × 25–30 µm, anticlinal walls jigsawed, inner periclinal walls pitted. *Flowering time*: October to early December. Figure 1.

*Erica dolfiana* is characterized by 4-nate leaves with relatively long petioles, relatively large bract and bracteoles about the size of the sepals, but remote from them, sepals white with long-stalked red marginal glands, urceolate glabrous white corolla, which is relatively small for the genus, glabrous anthers with long narrow appendages and thin filaments, enlarged subpeltate to peltate stigma, and the standard reticulate/alveolate ericoid-type seed.

*E. dolfiana* shows no close affinity to any other species. It may, however, be related to *E. lignosa* H.A.Baker, a widespread Swartberg species, and to *E. jugicola* E.G.H.Oliv. ined., a more restricted new species. Both have similar long-stalked red glands on the bract, bracteoles and sepals, but both have larger, pink flowers (very much larger in the latter) which are mostly finely hairy. They also have larger anther appendages and a small simple stigma. All three species are sympatric on the Blesberg.

\* Compton Herbarium, National Botanical Institute, Private Bag X7, 7735 Claremont, Cape Town.  
MS. received: 2001-04-02.

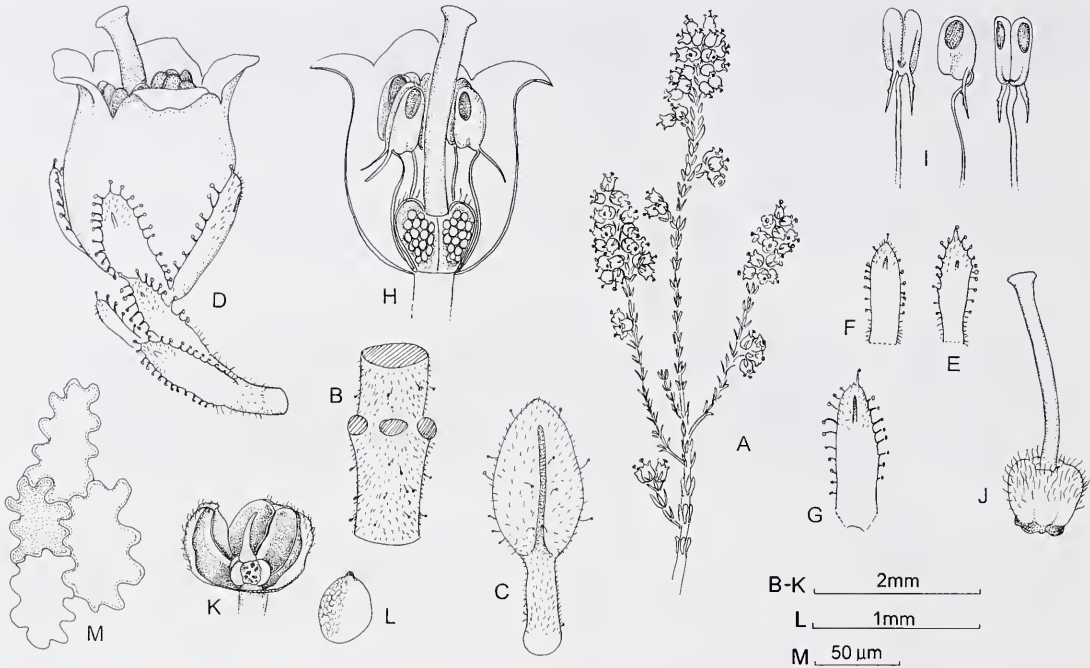


FIGURE 1.—*Erica dolfiana*. A, flowering branch, natural size; B, stem with leaves removed; C, leaf; D, flower; E, bract; F, bracteole; G, sepal; H, flower opened laterally to show androecium and gynoecium with ovary opened laterally; I, stamen, back, side and front views; J, gynoecium; K, capsule; L, seed; M, testa cells. A–J, drawn from the type collection, *Oliver & Oliver 11688*; K–M, from *Oliver 11576*. Scale bars: B–K, 2 mm; L, 1 mm; M, 50  $\mu$ m.

This new species is named after Dolf Schumann (1918–) senior author of that very fine illustrated book, *Ericas of South Africa* (Schumann & Kirsten 1992). He made collections of this and the next species on a joint trip with Jan Vlok in 1985. This is the second species of *Erica* that is named after him, the other being *E. schumannii* E.G.H.Oliv. (Oliver & Oliver 1998a).

*Erica dolfiana* is known thus far from only two localities—the small peak just north of Tierberg and the ridges west and east of Blesberg, some 40 kms to the east (Figure 2). In the latter locality, Pienaar, on the label of

his specimen 67, noted that west of the peak the species was fairly common on the upper northern slopes. Having visited Blesberg peak in July and January, out of the flowering season, we too saw numerous young plants but only in fruit.

The species is confined to southern and northern slopes at high altitudes where it grows in rocky/stony places with very short alpine fynbos. It is very common in the type locality where it is the dominant species of *Erica*. On the open slopes the shrublets, together with the other plants, are small and compact, whereas the few

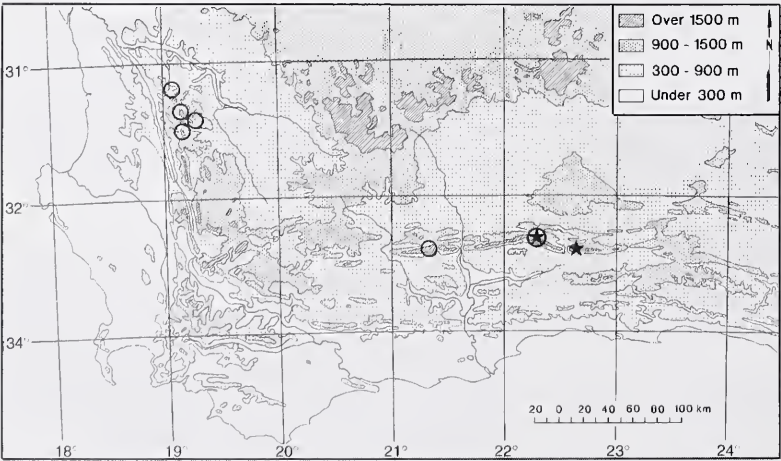


FIGURE 2.—Known distribution of *Erica dolfiana*, ★; *E. taylorii*, ○.



shrubs, among larger rocks in rocky areas, are looser and up to 500 mm tall.

Vlok noted that the flowers gave off puffs of pollen when disturbed. This was confirmed by us. The dull white colour of the flowers renders them relatively insignificant and, with the slightly enlarged stigma and somewhat reduced nectaries, suggest both insect- and wind-pollination strategies for the species (Rebello *et al.* 1985). However, the stickiness of the flower heads, caused by the glands on the bracts, bracteoles and calyx segments, may discourage foraging insects from clamoring around the inflorescences.

*Erica dolfiana* would seem to be another of those species in transition from insect- to wind-pollination, with its small white or dull-coloured flowers as found in so many other wind-pollinated *Erica* species. In our experience, size differences between the flowers of species point to different pollination syndromes, but not necessarily to different affinities. The other two undescribed species in this possible alliance have been observed by us to be pollinated by long-tongued flies.

#### Paratype material

WESTERN CAPE.—3322 (Oudtshoorn): Great Swartberg, peak due south of highest point of jeep track, 2 000 m. (–AD), 5-11-1985, Schumann 390 (NBG); peak behind Tierberg, 5800 ft. (–AD), 5-11-1985, Vlok 1266 (K, NBG, NY, PRE); Blesberg, neck just E, 2 000 m. (–BC), 13-07-2000, fruiting, Oliver 11576 (NBG); *ibid.*, 6-01-2001, fruiting, Oliver 11764 (NBG); *ibid.*, neck just W, 5900 ft. (–BC), 12-11-1976, Pienaar 67 (NBG).

2. *Erica taylorii* E.G.H.Oliv., sp. nov., pilis longis in marginibus foliorum, bracteae, bracteolarum et sepalorum, bractea bracteolisque magnis subpetaloideis, antheris calcaribus brevibus crassis, ovario ramisque puberulis dignoscenda. Figura 3.

TYPE.—Western Cape, 3322 (Oudtshoorn): Oudtshoorn, Groot Swartberg, peak just north of Tierberg, 2 010 m. (–AD), 17 October 2000, E.G.H. & I.M. Oliver 11691 (NBG, holo.; BM, K, MO, NY, P, PRE).

*Erica oresigena* Bolus var. *mollipila* Bolus in Guthrie & Bolus: 129 (1905). Types: Worcester Div., on the Matroos Berg, Bolus s.n. (BOL?); Clanwilliam Div.: Sneeuwkop, Cederberg Range near Wuppertal, Bodkin sub Bolus 6492 (BOL!).

Illustration.: Schumann & Kirsten: 112, fig. 49, 50 (1992).

Low, prostrate, spreading shrublet up to 200 mm tall and 0.5(–1.2) m across, single-stemmed reseeder. Branches: main branches mostly prostrate, numerous old and woody; numerous secondary branches  $\pm$  100–300 mm long, erect, with occasional  $\pm$  5–10 mm long tertiary branches, all ending in a florescence, internodes very short, all covered with fine dense short retrorse hairs, occasionally interspersed with few plumose hairs on older branches. Leaves 3- or 4-nate, imbricate, oblong, 3–5  $\times$  1 mm, erect, adaxially flattened, abaxially rounded, with acute margins, finely hairy on both sides and with short, stout, plumose hairs on margins, sulcus narrow, closed at base; petiole 0.6–0.8 mm long, puberulous and edged with a few short, stout, plumose hairs. Inflorescence: flowers 3 or 4 in 1(–3) whorls, terminal on

secondary and tertiary branches; pedicel 2.0–3.5 mm long, finely hairy with retrorse hairs and occasionally short, stout, plumose hairs interspersed, reddish; bract partially recalcrescent from  $\frac{1}{4}$ – $\frac{1}{2}$  way up pedicel, oblong to lanceolate, 3.5–4.5  $\times$  1.0–1.2 mm, cream to reddish pink, sometimes with green mainly in upper half, glabrous to finely hairy, with long, plumose marginal hairs, sulcus narrow,  $\frac{1}{2}$  length of bract; bracteoles 2, placed  $\frac{3}{4}$  way up pedicel, 3.0  $\times$  0.7–1.0 mm, otherwise like bract. Calyx 4-partite, segments slightly imbricate, broadly lanceolate to ovate, 3.5–4.5  $\times$  1.0–1.5 mm, reddish pink, glabrous to finely hairy, margins with long, plumose hairs, sulcus  $\frac{1}{2}$  length of segment. Corolla 4-lobed, 6–9  $\times$  3–5 mm, ovoid-urceolate, finely puberulous to glabrous, pink to dark pink, hairs white; lobes spreading-recurved, rounded, 1.5–2.0  $\times$  1.8–2.5 mm, erose. Stamens 8, included, free; filaments linear,  $\pm$  4 mm, slightly widening to base, with slight bend below anther, glabrous, white; anthers bilobed, narrowly ovate to oblong in adaxial view, dorsally attached near base, appendiculate; thecae ovate to elliptic in lateral view, 1.0–1.2  $\times$  0.5–0.6 mm, erect, brown, very finely aculeate, pore small  $\frac{1}{4}$ – $\frac{1}{5}$  length of theca, spurs subspreading, abaxially  $\pm$  0.6  $\times$  2.5 mm, occasionally toothed, pink; pollen in tetrads. Ovary 4-locular, broadly obovoid to globose, 2–3  $\times$  2–3 mm, emarginate, covered with dense, short hairs, red, with dark nectaries around base; ovules 40–50 per locule, spreading laterally from full-length placenta; style included,  $\pm$  4.5–5.0 mm long, glabrous, dull red; stigma capitate, dark red. Fruit a dehiscent capsule,  $\pm$  2.5  $\times$  3.5 mm, valves splitting  $\frac{3}{4}$  their length and to 45° angle, septa only on valves, placenta large, convoluted and warty. Seeds ellipsoid,  $\pm$  0.6  $\times$  0.35 mm, shallowly reticulate-alveolate, brown; testa cells  $\pm$  100  $\times$  40  $\mu$ m, anticlinal walls jigsawed, inner periclinal walls densely pitted. Flowering time: October to December. Figure 3.

In *Flora capensis* Bolus (1905) described the variety *mollipila* of his *E. oresigena*, based on collections from Matroosberg and the Cederberg. Hugh Taylor, who studied the vegetation of the Cederberg, expressed surprise, since he knew *E. oresigena* and did not think that Bolus' variety *mollipila* belonged to the same species. It is a mystery to us why Bolus did not describe the variety *mollipila* as a separate species, since our studies have shown that the two taxa differ in many critical characters which indicates that this taxon is more closely related to species other than *E. oresigena*. The only similar characters are those of the anthers. *E. oresigena* is an upright, woody, rounded bush 0.5–1.5 m tall. It is distinguished by its long pedicels, entire corolla lobes, short, woolly hairs on the pedicel and sepals, large dark red glands on the margins of the bract, bracteoles, sepals and young leaves, and by the ovary which is glabrous.

*Erica taylorii*, here described *de novo* as a distinct species, is related to the group of species which is characterized by plumose hairs and large, coloured, petaloid bract and bracteoles. The group includes the *E. goatheriana* L.Bolus complex, *E. modesta* Salisb. and the recently described *E. schumannii* E.G.H.Oliv. (Oliver & Oliver 1998a) and *E. kirstenii* E.G.H.Oliv. (Oliver & Oliver 2000). *E. taylorii* differs in having very few, relatively short (not numerous and dense), plumose hairs on

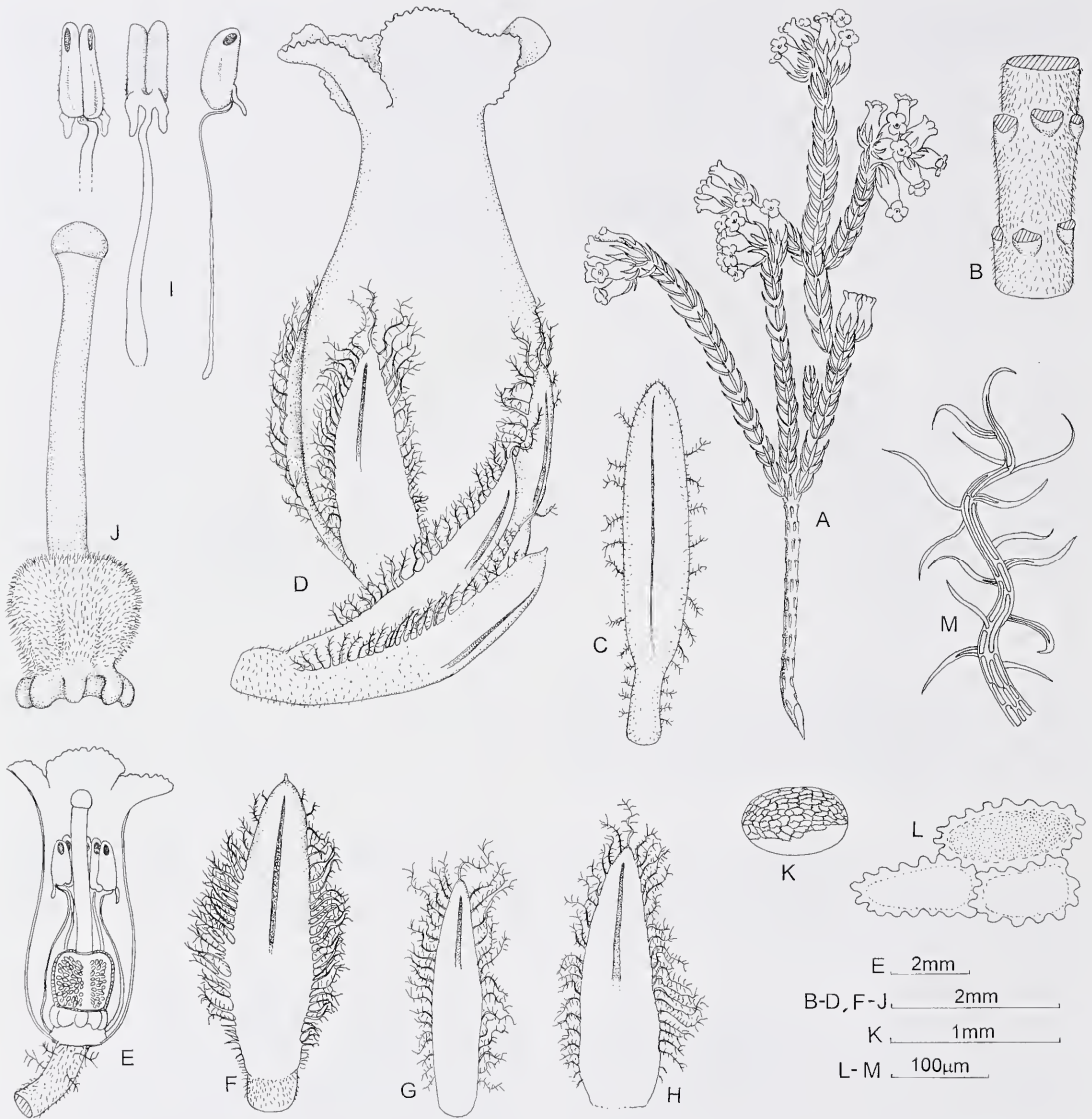


FIGURE 3.—*Erica taylorii*. A, flowering branch, natural size; B, stem with leaves removed; C, leaf; D, flower; E, flower with corolla and ovary cut open laterally; F, bract; G, bracteole; H, sepal; I, stamen, front, back and side views; J, gynoecium; K, seed; L, testa cells; M, typical multiserial plumose hair. A–J, drawn from the type collection, *Oliver & Oliver 11691*; K & L, drawn from *Oliver 10007a*. Scale bars: B–J, 2 mm; K, 1 mm; L, M, 100 µm.

the pedicel, and flowers in one, sometimes up to three whorls. This latter character relates the species to two species with plumose hairs and umbel-like inflorescences, namely *E. cernua* C.V.Montin and *E. sphaerocephala* J.C.Wendl. ex Benth. The former has a globose corolla and larger anther appendages, whereas the latter has much reduced bracteoles and sepals (not large and petaloid), and long-aristate leaves, bract, bracteoles and sepals.

This new species is named after the vegetation ecologist, the late Hugh Taylor (1925–1999), a colleague and friend of many years who had a profound knowledge of the Cape Flora (McDonald *et al.* 2000). He collected many fine herbarium specimens, including one of this

species, made during his major vegetation survey of the Cederberg Mountains.

*Erica taylorii* occurs in two widely separated areas, the Swartberg Range above Ladismith and Oudtshoorn, and the Cederberg Mountains east of Clanwilliam (Figure 2). It is variable in the number of leaves per whorl, number of flowers per inflorescence and in the size of the corolla, which can be hairy or glabrous.

The Cederberg populations have 3- or 4-nate leaves, whereas the Swartberg populations have only 4-nate leaves. Most plants have a hairy corolla with the variation in indumentum not linked to any specific area. The totally glabrous form occurs in *Schumann 380* with the



type collection having a few flowers with some hairs on the corolla lobes and slightly more in *Vlok 1263*. The Seweweekspoort populations are all finely puberulous. All the collections from the Cederberg have a hairy corolla, except for a few branches on *Bond 1403*, which have very short hairs only on the corolla lobes.

The eastern populations of the species are confined to the Swartberg Range in two widely separated areas, one above Ladismith along the Klein Swartberg in the region of Seweweekspoort Mtn. and the other some 90 kms to the east in the Tierberg area above Oudtshoorn. It is surprising that no collections have been made on any of the numerous intervening peaks where suitable habitats surely occur, despite visits to these peaks by Stokoe, Esterhuysen, Taylor and ourselves. We have selected our recently collected material near Tierberg as the type of the species, since it provided adequate isotypes and excellent fresh material for us to study.

The type population was very localized on a small, very low rocky ridge on the southern slopes, just below the summit of the minor peak north of Tierberg. A few plants were also found on nearby rocky outcrops. The plants grew in crevices on the rocks and between rocks and spread out over the surface for up to half a metre. They were woody and in some cases had gnarled stems. The open slopes surrounding the low ridge were covered with numerous plants of *E. dolifiana* (see above) in very short, alpine-like vegetation.

On the peaks just west of Seweweekspoort, *E. taylorii* is apparently more common, judging by the collection records of 'frequent'. It was collected there by Andreae, Barnard, Primos and Stokoe on the first expedition to the Klein Swartberg in 1928 (Linder *et al.* 1993). On Hoeko Peak we noted numbers of low, spreading plants growing among short restiads and in rock crevices on northern slopes, but only in fruit. Andreae recorded the plants as 'low spreading shrublets on ground or adpressed to rocks on flat open places'. Vlok noted that plants were 'frequent on southern slope between large rock blocks', which could explain why he recorded the height of the plants as  $\pm 1.2$  m, if they grew up among the rocks.

The populations in the Cederberg Mtns occur on the highest peaks from Krakadouw to Sneeuberg, a distance of 30 kms. Pocock, who made numerous collections of plants in the Cederberg in the mid-1920s, noted on her collection 650 'found on all the high peaks but nowhere abundant except on Krakadouw Great Peak'.

While looking for *E. cedromontana* E.G.H.Oliv. (Oliver & Oliver 1998b) on the Langberg, we searched for *E. taylorii* too, but did not locate any plants. Thus details of the habit and habitat are taken from other collectors' notes. Pocock recorded plants as 'low shrubs 3–15 inches tall, growing on small vlaktes and crannies among rocks on Krakadouw' and 'stunted shrub in cracks in rocks' on Sneeuksop summit. Taylor recorded it as growing 'in small *Ischyrolepis curviramis* sand flat on bedrock' and Stehle gave 'on rocks'.

Esterhuysen gave a detailed record of the species on the Sneeuberg when she collected some old fruiting

material in April. She wrote 'plants were common and conspicuous on the south side in rocky places—mostly growing from rock crevices in flat or sloping rock and spreading out over rocks forming low dense masses, protected from fires'. She also made the interesting observation that the plants were rooting along the stems.

The record by Harry Bolus of a *Bolus s.n.* specimen from Matroosberg, a syntype of his *E. oresigena* var. *mollipila*, was regarded by us as doubtful. This collection was not filed under *E. oresigena* in BOL, but was noted on the sheet as having been removed by Elsie Esterhuysen to *E. maderi* where, unfortunately, it cannot now be found. The collection must have consisted of a flowering branch 100 mm long, deduced from the clear imprint on the sheet where it had formerly been mounted and annotated by Bolus, and certainly gives the impression of being *E. maderi*, which is common on the lower slopes of Matroosberg. A collection of that species from Matroosberg by Alfred Bolus is housed in SAM. The other syntype of the variety, which was collected by Bodkin from the Cederberg, consists of three small branchlets in poor condition with just six buds and six mature flowers.

#### Paratype material

WESTERN CAPE.—3219 (Wuppertal): Krakadouw Peak, summit, 5900–6700 ft. (–AA), *Pocock 650* (NBG); Groot Krakadouw, summit massif, 1 700 m. (–AA), 22 November 1987, *Taylor 11905* (NBG); Sneeuksop, (–AC), *Bodkin sub Bolus 6492* (BOL); *ibid.*, 5500–6300 ft, 6-04-1969, fruiting, *Esterhuysen s.n.* (BOL); *ibid.*, 6300 ft, 13-10-1923, *Pocock 214* (NBG); Langberg, 6000 ft, 15-12-1941, *Bond 1403* (NBG); *ibid.*, 15-12-1941, *Esterhuysen 7306* (BOL, SAM); Sneeuksop Peak, 6200 ft. (–AC), 2-12-1969, *Stehle 310* (NBG); Wolfberg Arch area, (–AD), 28-11-1959, *Jessop sub Oliver 324* (NBG). 3321 (Ladismith); Toverkop, 6000–7000 ft. (–AC), 15-12-1956, *Esterhuysen 26759* (BOL); Seven Weeks Poort Mtn, 2 300 m. (–AD), 26-12-1928, *Andreae 1181* (BOL, NBG); *ibid.*, 5000–7000 ft, 12-1928, *Barnard in SAM46306* (SAM); *ibid.*, 1 800–2 100 m, 26-12-1928, *Primos 16* (BOL, NBG); *ibid.*, 7200 ft, 26-12-1928, *Stokoe 1878* (BOL); *ibid.*, 7500 ft, 5-01-1981, *Vlok 140* (NBG); Hoeko Peak, 1 900 m. (–AD), 4-02-1992, fruiting flowers only, *Oliver 10007a* (NBG). 3322 (Oudtshoorn); Great Swartberg, peak north of Tierberg, 6250 ft. (–AD), 5-11-1985, *Vlok 1263* (NBG); *ibid.*, 1 900 m, 5-11-1985, *Schumann 389* (NBG, PRE).

#### THE ERICA ESTERHUYSENIAE COMPLEX

The following three new species form a complex with *E. esterhuyseniae* Compton. They are all confined to high altitudes along the Klein and Groot Swartberg ranges and in some places grow sympatrically.

*Erica esterhuyseniae* was described by Compton in 1941 (Compton 1941). In the protologue he divided the species into two varieties, var.  $\alpha$  *tetramera* and var.  $\beta$  *trimera* based on the distinction of 4-nate versus 3-nate leaves. According to the current nomenclatural rules he should have retained the epithet '*esterhuyseniae*' under the autonym rule for the var.  $\alpha$  (Oliver & Oliver 1994).

We support Compton's recognition of two separate taxa, but with all the additional material available to us, feel that there are sufficient grounds for separating them at specific level. The number of leaves per whorl is a clear distinction, but one which Compton felt was of 'less systematic importance' in *E. esterhuyseniae*. There

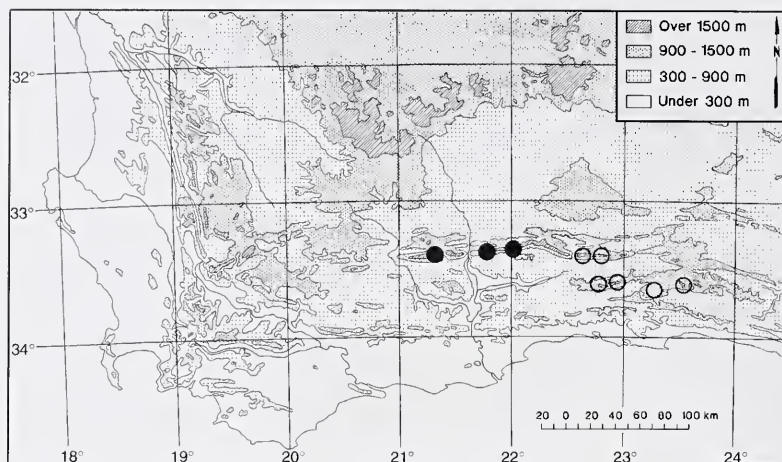


FIGURE 4.— Known distribution of *Erica oreotragus*, ●, and *E. esterhuyseniae*, ○.

are, however, several other characters which he did not notice and which can be used to distinguish the two taxa (see below).

**3. *Erica esterhuyseniae* Compton:** 193 (1941) pro *E. esterhuyseniae* var. *α tetramera*; Dulfer: 75 (1965); *E. esterhuyseniae* var. *esterhuyseniae*, E.G.H.Oliv. & I.M.Oliv.: 27 (1994). Type: Cape Province. Uniondale Division: Kamanassiberg [Kammanassie] (Mannetjiesberg), 1 700 m, 1-02-1941, *Compton 10557* (NBG!).

Illustration: Compton: 194, fig. 3 (left), 1–12 (1941).

*Erica esterhuyseniae* is characterized by the 4-nate leaves which are relatively broad, open-backed and curve inwards, and the long, narrow, almost acuminate, corolla lobes  $\frac{1}{3}$ – $\frac{1}{2}$  length of corolla. It is allied to *E. oreotragus* and *E. blairioides* (see below).

The species occurs on the far-eastern portion of the Swartberg Range around Blesberg, on the Karoo inselberg—the Kammanassie Mtns just to the south, and on the western half of the Kouga Mtns (Figure 4). In all localities it grows on the south-facing upper slopes in sandy loamy soil, or in areas where there is more moisture in winter, which is the case with our recent collection, *11799*, from the drier foothill ridge just north of the main range of Blesberg.

#### *Specimens examined*

WESTERN CAPE.—3322 (Oudtshoorn): Blesberg, (–BC), 17-10-1955, *Esterhuysen 24917* (BOL); *ibid.*, 2 040 m, 13-07-2000 (fruiting), *Oliver 11549* (NBG); *ibid.*, 1 960 m, 7-01-2001, *Oliver 11779* (NBG); *ibid.*, northern foothill ridge, 1 840 m, 7-01-2001, *Oliver 11799* (NBG); Great Swartberg at Kolberg, 1 500 m, (–BD), 20-03-1983, *Schumann 93* (NBG); Kammanassie Mtns, Buffelsberg, 5000 ft, (–DB), 29-01-1929, *Viviers & Vlok 37* (NBG); Kammanassie Mtns, Mannetjiesberg, (–DC), 1-02-1941, *Compton 10557* (NBG); *ibid.*, 5000 ft, 1-02-1941, *Esterhuysen 4762* (BOL, K, PRE); *ibid.*, 1 800 m, 9-01-2001, *Oliver 11831* (NBG). 3323 (Uniondale): Hoopsberg, 5000 ft, (–CB), 12-03-1966, *Rourke 399* (NBG); Kouga Mtns, Saptoukop, 1 530 m, (–DA), 16-12-1991, *Oliver 9938a* (NBG).

**4. *Erica oreotragus* E.G.H.Oliv., sp. nov., *Ericae esterhuyseniae* Compton affinis sed ab ea foliis ternatis**

*angustioribus sulco minus aperto, lobis corollae angustioribus, calcaribus antherarum latioribus differt. Figura 5.*

*E. esterhuyseniae* Compton var. *trimera* Compton: 193 (1941); Dulfer: 75 (1965); E.G.H.Oliv. & I.M.Oliv.: 27 (1994). Type: Cape Province. Oudtshoorn Division: Swartberg Pass, 2 000 m, 28-12-1941, *Bond 866* (NBG, holotype; BOL!, PRE).

Illustration: Compton: 194, fig. 3 (right), 1–10 (1941).

Erect, sparse to suberect and compact, shrublet, 300–400 mm high, single-stemmed reseeder. *Branches*: numerous main branches 50–100 mm long, terminating in an inflorescence, internodes 2–10 mm long, occasional short, secondary branches 2–5 mm long with or without terminal inflorescence; all branches covered with dense, short, spreading hairs or with short and long hairs intermixed. *Leaves* 3-nate, erect incurved, broadly ovate to elliptic, 2.0–3.2 × 0.8–1.3 mm, subacute, adaxially flat, abaxially rounded, margins acute, densely hairy on both surfaces, sulcus partially open, closed at base; petiole ± 1 mm long, hairs all over or only on margin. *Inflorescence*: flowers 3-nate in 2, rarely 3, whorls in umbel-like group at apices of main and secondary branches; pedicel ± 1.2 mm long, glabrous to finely and shortly hairy; bract partially recalcrescent, in mid position on pedicel, narrowly lanceolate to linear, 0.7–1.6 × 0.1 mm, variable in size in an inflorescence, glabrous but ciliate along margin, esulcate, greenish red to whitish; bracteoles 2, in mid position, minute or reduced to just a tuft of hairs within an inflorescence, esulcate. *Calyx* 4-partite, very slightly fused at base; segments lanceolate to ovate, 1.5–1.8 × 0.5 mm, subacute, puberulous to glabrescent, ciliate with long, spreading hairs and occasionally 1 or 2 minute subsessile to sessile glands, sulcus fairly broad,  $\frac{1}{3}$ – $\frac{1}{2}$  length of lobe. *Corolla* 4-lobed, urceolate, ± 3.3 × 2.0 mm, with 4 bulges at base, densely hairy with short and long spreading hairs admixed, pale pinkish to white; lobes spreading, ± 1 mm long, broadly rounded, subacute to obtuse, margins minutely crenulate to entire. *Stamens* 8, included, free; filaments ± 1.5 mm long, widening towards base, with marked apical S-bend; anthers bilobed, elliptic in outline in adaxial view, dorsally attached near base, appendiculate; thecae erect adpressed, narrowly ovate-elliptic in lateral view, ± 0.8 × 0.3 mm, glabrous, smooth,



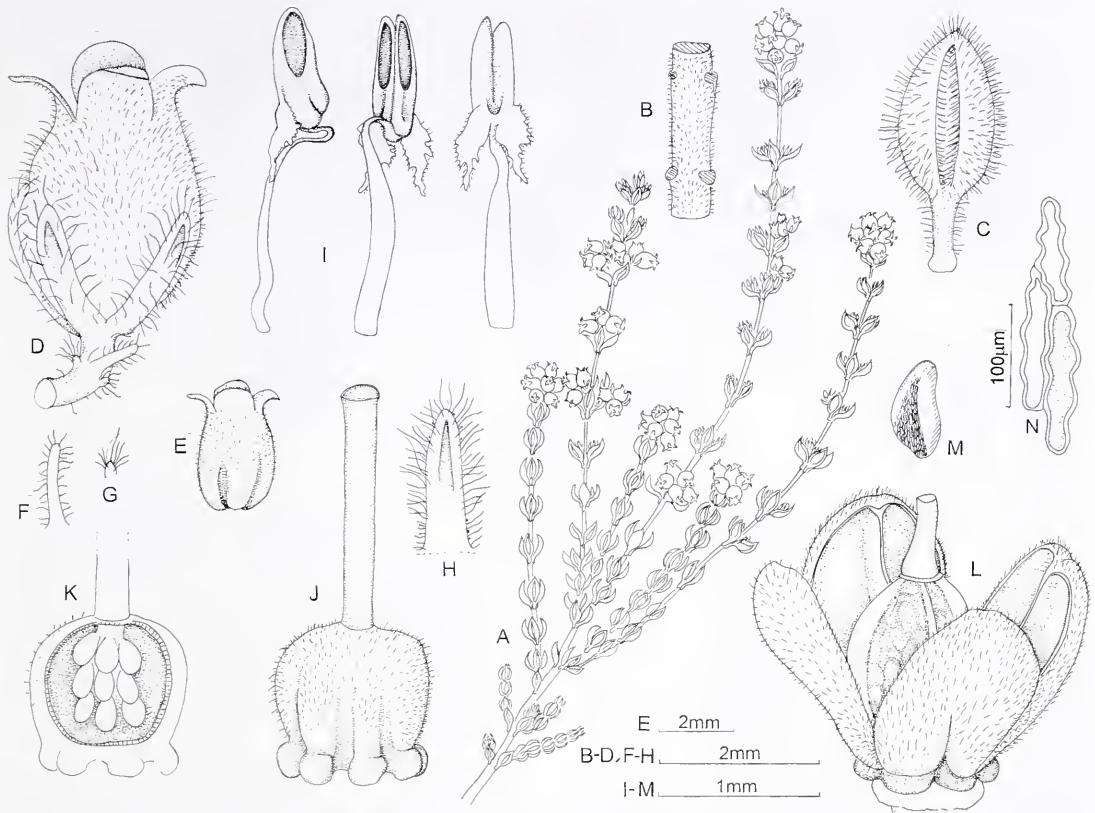


FIGURE 5.—*Erica oreotragus*. A, flowering branch, natural size; B, stem with leaves removed; C, leaf; D, flower; E, corolla; F, bract; G, bracteole; H, sepal; I, stamen, side, front & back views; J, gynoecium; K, ovary opened laterally; L, capsule; M, seed; N, testa cells. All drawn from the type collection. Scale bars: B–H, 2 mm; I–M, 1 mm.

brown, pore  $\pm \frac{1}{2}$  length of theca; spurs  $\pm 0.6 \times 0.2$ – $0.1$  mm, attenuate from broad flat base, unevenly serrate to entire and shortly ciliate, brown; pollen in tetrads. Ovary 4-locular, globose,  $\pm 1 \times 1$  mm, obtuse, densely and shortly hairy, with distinct nectaries around base; ovules  $\pm 9$  per locule, pendulous from placenta in upper  $\frac{2}{3}$ ; style included, terete, glabrous, white; stigma simple, rounded, reddish. Fruit a dehiscent capsule,  $\pm 1.7 \times 2.2$  mm, valves fused up to  $\frac{1}{5}$  their length spreading to  $45^\circ$ , equally on valves and columella. Seeds  $\pm 0.6 \times 0.3$  mm, 4-ridged, abaxially rounded, laterally and adaxially flattened, reticulate, orange-yellow, testa cells  $100$ – $125 \times 27$   $\mu\text{m}$ , with undulate thick anticlinal walls, periclinal walls with a few very small pits. Flowering time: December to March. Figure 5.

This new species and the other two new species described here, namely *E. blaerioides* and *E. chionodes*, are closely allied to *E. esterhuyseniae*. All three new species, however, have 3-nate leaves, whereas in *E. esterhuyseniae* they are 4-nate.

*Erica oreotragus* occurs on the Klein Swartberg and on the western and central portions of the Groot Swartberg (Figure 4) with no areas of overlap with *E. esterhuyseniae*, which occurs much further east. It grows sympatrically with *E. blaerioides* in the Botes Nek area (see below).

The epithet for this, the commoner of the two former varieties of *E. esterhuyseniae*, is derived from *Oreotragus oreotragus*, the scientific name of the small klip-springer buck which is often seen in the Cape folded mountains. We who have the privilege of knowing the remarkable Elsie Esterhuysen (1912–) and of having been out in the mountains collecting with her, will always have visions of a metaphorical klipspringer hopping from rock to rock and darting around the slopes, selecting choice plants for the collecting bag and press. Elsie is in her element roaming these Cape mountains. This epithet is chosen in fond remembrance.

#### Paratype material

WESTERN CAPE.—3321 (Ladismith): Klein Swartberg, N slopes of Hoeko Peak, 2 080 m, (–AD), 3-02-1992, *Oliver 10004* (NBG, PRE); Seven Weeks Poort Mtn, 7000 ft, (–AD), 12-1928, *Primos 24* (BOL, NBG, PRE); Calitzdorp area, Groot Swartberg in Botes Nek area, 6000 ft [1 830 m], (–BD), 31-12-1969, *Oliver 3068* (NBG). 3322 (Oudtshoorn): Swartberg Pass, 1 590 m, 6-02-1986, *Brusse 4866* (NBG, PRE); *ibid.*, 5000 ft, 25-01-1941, *Esterhuysen 4513* (BOL); *ibid.*, 5000 ft, 25-01-1941, *Esterhuysen 4772* (BOL); *ibid.*, 28-01-1961, *Esterhuysen 28806* (BOL, K, PRE); *ibid.*, S side, 1 500 m, (–AC), 01-1979, *Oliver 7407* (NBG); *ibid.*, 03-1942, *Stokoe in SAM55440* (SAM). Swartberg, without precise locality, 01-1935, *Stokoe 6668* (BOL).

5. *Erica chionodes* E.G.H.Oliv., sp. nov., synflor-  
escentibus longis densis spicatis, floribus niveis puberu-

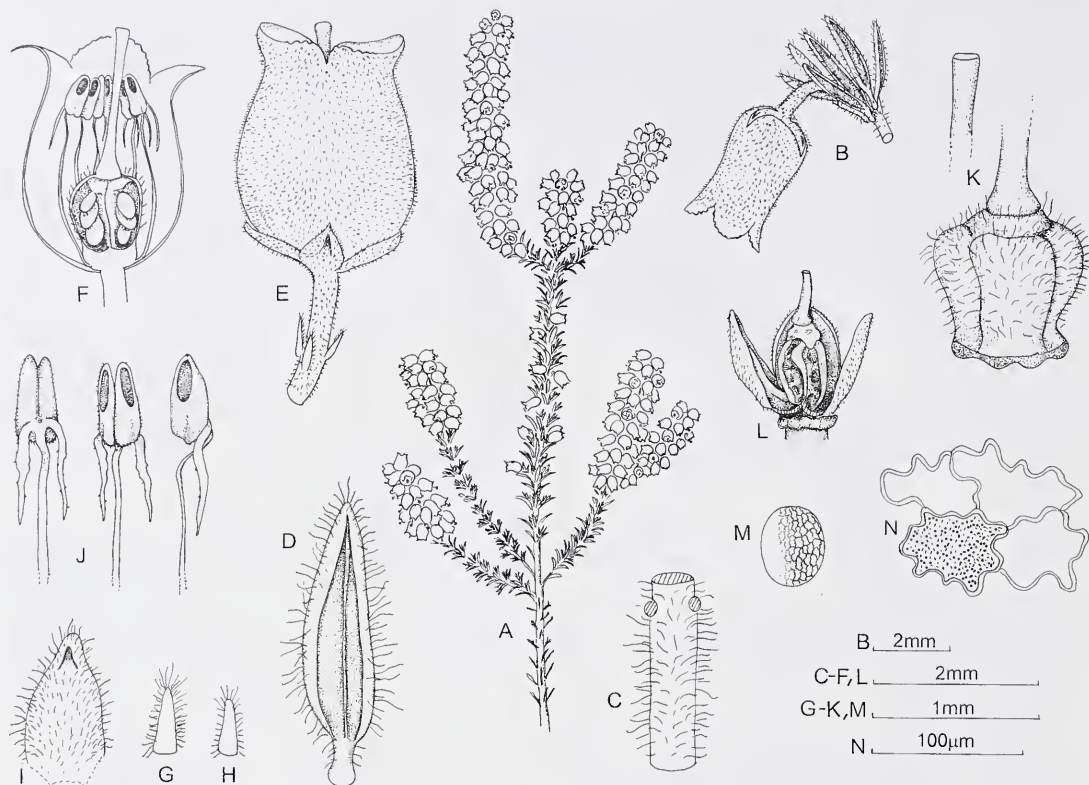


FIGURE 6.—*Erica chionodes*. A, flowering branch, natural size; B, lateral flowering branchlet; C, stem with leaves removed; D, leaf; E, flower; F, flower, half section; G, bract; H, bracteole; I, calyx lobe; J, stamen, back, front and side views; K, ovary and stigma; L, capsule with one valve removed; M, seed; N, testa cells. All drawn from the type collection. Scale bars: B–F, L, 2 mm; G–K, M, 1 mm; N, 100  $\mu$ m.

lis, ramis puberulis, foliis abaxialiter semipatentibus, calcaribus antherarum longis angustis, ovario hirsuto dignoscenda. Figura 6.

**TYPE.**—Western Cape, 3322 (Oudtshoorn): Oudtshoorn, Groot Swartberg, peak just north of Tierberg, small kloof WNW of peak, 1 720 m, (–AD), 17 October 2000, *E.G.H. & I.M. Oliver 11699* (NBG, holo.; BM, BOL, K, MO, NY, P, PRE, S).

Illustration: pro *E. esterhuyseniae*, Schumann & Klirsten: 116, fig. 70, 71 (1992).

Erect, sparse to compact shrub up to 600 mm tall, single-stemmed reseeder. *Branches*: main branches erect 30–50(–80) mm long, with determinate, occasionally continuing growth; secondary branchlets very short,  $\pm$  1–2 mm long on every node; tertiary branchlets occasional,  $\pm$  1 mm long on previous year's secondary branchlets; all branches pilose to hirsute with spreading hairs. *Leaves* 3-nate, subspreading, narrowly lanceolate-oblong, 2.5–3.5  $\times$  0.4–1.2 mm, adaxially flat, abaxially rounded with rounded margins, partially open-backed, sulcus broad, open at base, pilose to hirsute all over except in sulcus; petiole 0.5 mm long, pilose. *Inflorescence*: flowers 1(–3)-nate on ends of secondary, and occasionally tertiary, branchlets, crowded along and towards ends of main branches in dense spike-like synflorescences 100(–200) mm long; pedicel 1.7 mm long,

pilose, pale red; bract partially recalcrescent about  $\frac{1}{6}$  way up pedicel, narrowly lanceolate, 0.4  $\times$  0.15 mm, not sulcate, pilose, white; bracteoles 2, like bract but placed slightly higher up pedicel and slightly smaller. *Calyx* 4-lobed, 0.9  $\times$  0.5 mm, tube about  $\frac{1}{6}$  length of calyx; lobes ovate, adpressed to corolla, with very short, subapical, wide sulcus, puberulous, very pale green to white. *Corolla* 4-lobed, urceolate, 2.8–3.8  $\times$  2.0 mm, puberulous, white; lobes 0.8  $\times$  1.0 mm, rounded, erose. *Stamens* 8, included; filaments free, linear,  $\pm$  2 mm long, with slight apical S-bend, glabrous, white; anther bilobed, dorsally attached near base, ovate in adaxial view, appendiculate; thecae erect adpressed, ovate-elliptic in lateral outline,  $\pm$  0.5  $\times$  0.3 mm, aculeate, brown, spurs irregularly linear-lanceolate,  $\pm$  0.7 mm long, slightly longer than thecae, pendulous, with few lateral teeth, yellowish, pore  $\frac{1}{3}$ – $\frac{1}{2}$  length of theca; pollen in tetrads. *Ovary* 4-locular, broadly obovoid,  $\pm$  1.0  $\times$  0.9 mm, rounded, finely hairy all over, green, with reddish green apical portion and dark red nectaries around base; ovules  $\pm$  6 per locule, pendulous from placenta in upper half of locule; style manifest, 2 mm long, dull reddish; stigma truncate to sub-capitulate, dull red. *Fruit* a dehiscent capsule,  $\pm$  1.5  $\times$  1.8 mm, valves fused  $\pm$   $\frac{1}{4}$  at base, opening to  $\pm$  45° angle; septa about equally split on valve and columella. *Seeds* ellipsoid,  $\pm$  0.5  $\times$  0.4 mm, slightly flattened laterally, testa medium hard in texture, orange, reticulate-alveolate, cells 60–75  $\times$  35–45  $\mu$ m, anticlinal walls undulate to slightly jigsawed, inner periclinal wall pitted



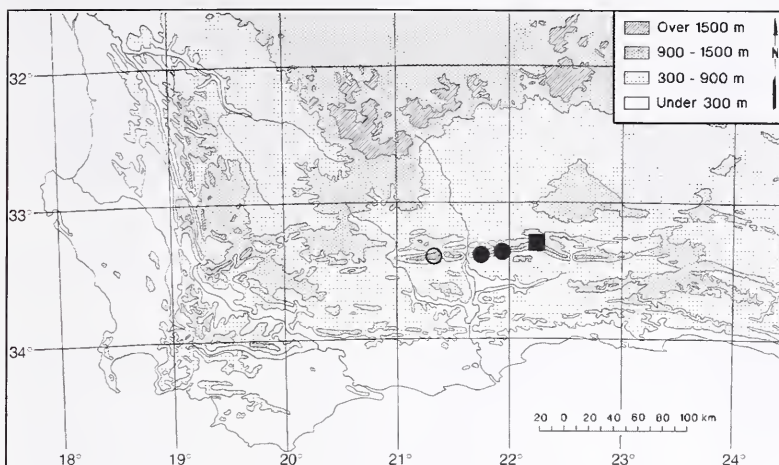


FIGURE 7.—Known distribution of *Erica chionodes*, ■; *E. blaerioides* subsp. *blaerioides*, ●; *E. blaerioides* subsp. *hirsuta*, ○.

with fairly large pits occasionally coalescing. *Flowering time*: September to November. Figure 6.

*Erica chionodes* is distinguished by the long, dense, spike-like synflorescences with pure white, finely hairy flowers, partially open-backed leaves, long, narrow, pendulous anther appendages and hairy ovary. It is closest to *E. oreotragus* E.G.H.Oliv. (see above) which is common along the full length of the Swartberg Range and has flowers in terminal 6–8-flowered heads on main branches (not in spike-like synflorescences), glabrous, mostly shorter pedicels, longer sepals which are about half the length of the corolla and have fewer longer hairs, relatively long corolla lobes, and anther appendages shorter than the thecae and broader and hairy. It is also allied to the new species, *E. blaerioides* (see below).

The species was studied by us in a large kloof on the northwest side of Tierberg above the Cango Caves, Oudtshoorn (Figure 7), where we saw just two populations. Both are growing in seepage areas with a predominance of low, matted species of Restionaceae. The profusion of brilliant white flowers contrasted dramatically against the dark restiads and was reminiscent of patches of snow, hence the epithet, *chionodes* = like snow (Greek).

The type population was undoubtedly the one seen by the first and only other collectors of the species, Vlok & Schumann in 1985. In the kloof the species was common and grew together with another very striking, but pink-flowered species, *E. nervata* Guthrie & Bolus. The population was studied on a hot sunny afternoon when several flies and beetles were seen to visit the flowers. The flowers gave off no detectable scent. The population lower down and across the valley (11705) was growing in a pure stand of restiads in a seepage area close to the main stream and had older flowers.

There is a record from Toverberg above Ladismith in the Klein Swartberg by Esterhuysen (*Esterhuysen* 26768)—‘S slopes near base of shale band, slightly marshy’. No colour is recorded for the flowers. This specimen fits the species, but is more compact in growth with shorter synflorescences and has 4-nate leaves. The large gap between the two areas is similar to that in the previous species, *E. taylorii*, described here, and is also

surprising, although in this case the wet seepage habitat is very much scarcer than the rocky one of the latter.

#### Paratype material

WESTERN CAPE.—3322 (Oudtshoorn): Swartberg Mtns, main kloof running north just NW of Tierberg, sides of main stream, 1 400 m, (–AC), 17–10–2000, *Oliver 11705* (E, NBG, W); next to track near Tierberg, 4600 ft, (–AD), 5–11–1985, *Vlok & Schumann 1264* (BM, BOL, K, NBG, NY, PRE).

6. *Erica blaerioides* E.G.H.Oliv., sp. nov., *Erica oreotragus* E.G.H.Oliv. affinis, sed ab ea synflorescentibus breviter spicatis, bractea bracteola subaequantibus differt. Figura 8.

TYPE.—Western Cape, 3321 (Ladismith): Calitzdorp area, Groot Swartberg in Botes Nek area, 6000 ft [1 830 m], (–BD), 31 December 1969, *Oliver 3049* (NBG, holo.; BM, BOL, K, NY, PRE).

Erect, compact, much branched shrublet to 0.3 m, rarely 1.2 m tall, with thin twiggy branches, single-stemmed reseeder. *Branches*: numerous, thin; main branches 20–50(–100) mm long, with continuous apical growth, secondary branches 1–5 mm long ending in an inflorescence, all branches covered with simple short spreading hairs, internodes 1.0–1.5 mm long. *Leaves* 3-nate, erect, slightly incurved, occasionally spreading when older, lanceolate to elliptic, 1.7–2.2 × 0.6–0.8 mm, adaxially flat, abaxially rounded, with subacute margins, partially open-backed to narrowly sulcate, sulcus open at base, puberulous to sparsely so when young with longer apical tuft, glabrescent with age; petiole ± 0.5–0.9 mm long, glabrous, ciliate. *Inflorescence*: flowers 3 in 1 whorl at apex of secondary branches; pedicel ± 2.0–3.5 mm long, glabrous to puberulous; bract partially recalcrescent,  $\frac{1}{3}$ – $\frac{2}{3}$  way up pedicel, narrowly oblong to lanceolate, 1.4 × 0.2–0.3 mm, white, glabrous or sparsely puberulous, ciliate, sulcus very small or absent; bracteoles 2, slightly above bract, otherwise same as bract. *Calyx* 4-partite, very slightly fused at base; segments not imbricate, mostly adpressed to corolla, lanceolate to broadly so, ± 1.4–2.2 mm long, acute, white, glabrous or puberulous, ciliate with hairs and a few non-sticky short-stalked glands, sulcus ±  $\frac{1}{3}$  length of sepal,



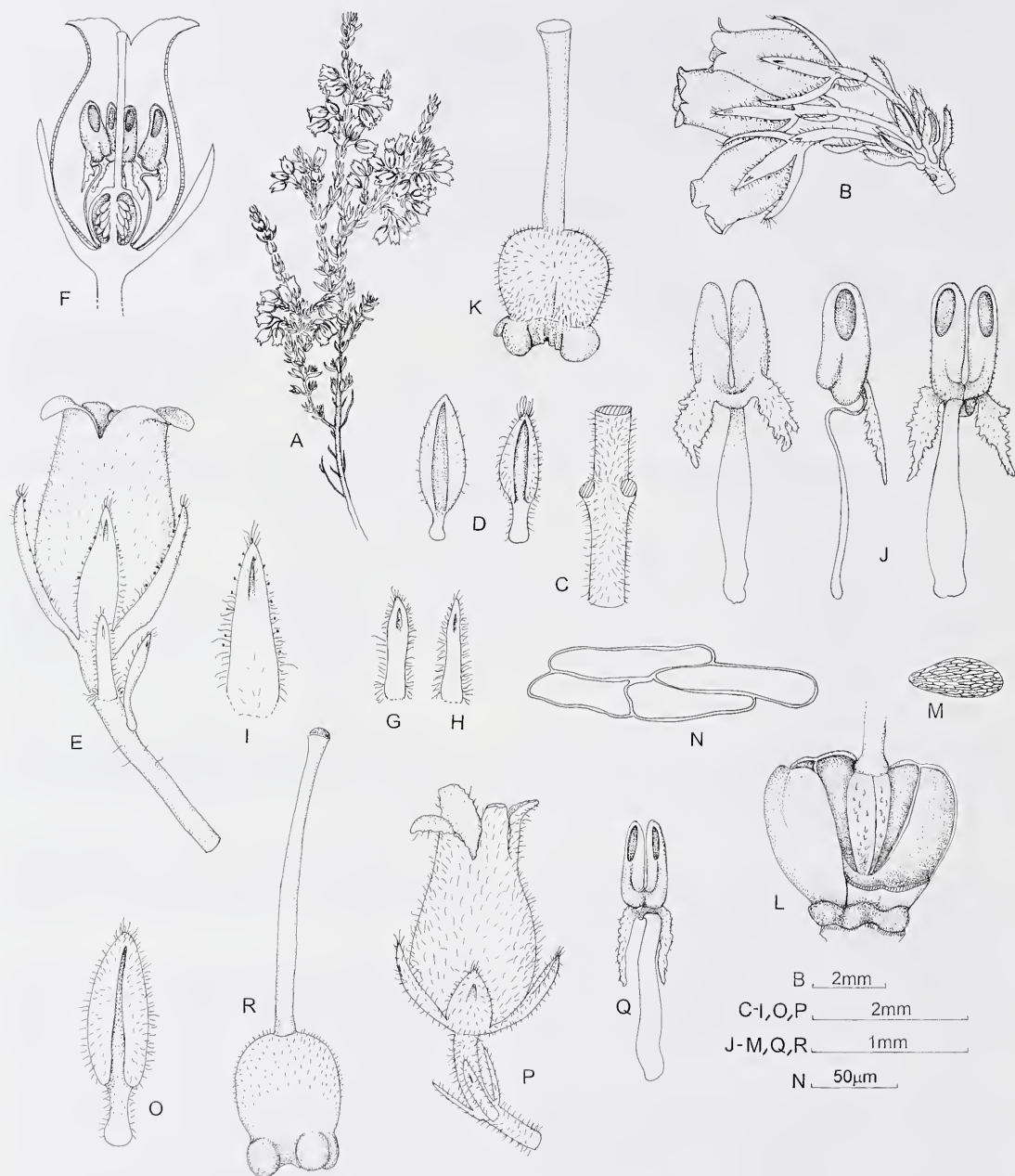


FIGURE 8.—*Erica blaerioides* subsp. *blaerioides*. A, flowering branch, natural size; B, flowering branchlet with single inflorescence; C, stem with leaves removed; D, two leaves; E, flower; F, flower, cut open longitudinally; G, bract; H, bractole; I, sepal; J, stamen, back, side and front views; K, gynoecium; capsule, with one valve removed; M, seed; N, testa cells. Subsp. *hirsuta*. O, leaf; P, flower; Q, stamen; R, gynoecium. A–N, drawn from the type of the species, *Oliver 3049*; O–R, from the type, *Oliver 5529*. Scale bars: B–I, O, P, 2 mm; J–M, Q, R, 1 mm; N, 50  $\mu$ m.

narrow. *Corolla* 4-lobed, narrowly urceolate, 3.2–3.4  $\times$  1.7–2.0 mm, sparsely puberulous to puberulous, white; lobes suberect to recurved, narrowly deltoid to broadly so, 0.6–0.9  $\times$  0.5 mm, subacute to rounded, margins crose. *Stamens* 4–8, free, included; filaments oblong, 1.2–1.5  $\times$  0.2 mm, slightly widened in middle or towards base, with marked apical S-bend, glabrous, white; anthers bipartite, erect, lanceolate to oblong in adaxial view, dorsally attached near base, appendiculate; thecae

erect adpressed, curved oblong in lateral view, 0.6–0.9  $\times$  0.2–0.3 mm, aculeate, brown, pore  $\pm$   $\frac{1}{3}$  length of cell, appendages irregularly shaped, 0.3–0.6  $\times$  0.1–0.2 mm, irregularly lacerate, puberulous; pollen in tetrads. *Ovary* 4-locular, broadly obovoid to globose, 0.8–1.0  $\times$  0.7 mm, very slightly emarginate, puberulous to puberulous in upper half only, with well developed nectaries around base; ovules 8–12 per locule, pendulous from placenta almost the length of columella; style included, straight,

1.5–2.0 mm long, glabrous; stigma simple truncate. *Fruit* a dehiscent capsule, valves splitting nearly to base and to  $\pm 45^\circ$ , delicate, not hard and woody, septa only on the valves. *Seeds* elongate ovoid,  $\pm 0.6 \times 0.3$  mm, orange, testa cells  $75\text{--}100 \times 25$   $\mu\text{m}$ , anticlinal walls slightly thickened, straight to very slightly and irregularly undulate, no pits in inner periclinal walls. Figure 8.

The species occurs at high altitudes only in the western parts of the Groot Swartberg Range and eastern Klein Swartberg (Figure 7).

*Erica blaerioides* is closely related to the previous two species. It has spike-like synflorescences similar to those of *E. chionodes*, but differs in these being looser and much shorter, in having longer sepals, a differently shaped corolla which is more sparsely hairy with longer hairs, differently shaped ovary, stamens in a lower position in the corolla and very different seeds. It is also allied in many respects to *E. oreotragus*, but differs in the form of its inflorescence which is spike-like and not umbel-like, and by its subequal bract and bracteoles.

This new species is divided into two subspecies on a number of characters, which show slight disjunctions—stamen number, size of the leaf sulcus, hairiness of the bract, bracteoles and sepals, and size of the sepals and anther appendages. The two taxa are allopatric. The type of the species and typical subspecies has been chosen from among the field collections made by the first author in the eastern populations.

#### subsp. *blaerioides*

Stamens always 4; bract, bracteoles and sepals glabrous but ciliate; leaves partially open-backed; longer, narrower sepals (1.6–2.0 mm long); broader, larger anther appendages (Figure 9A–N). *Flowering time*: December and January.

The typical subspecies has been recorded from the summit ridge of the Groot Swartberg from Botes Nek to above Kliphuisvlei (Figure 7) where it occurs on cool south-facing slopes. In the type locality the species occurred sympatrically with *E. oreotragus* and was easily recognizable as a distinct species mainly on the differences in the inflorescence types.

subsp. *hirsuta* *E.G.H.Oliv.*, subsp. nov., a subspecies typica foliis minus sulcatis, omnibus partibus floris (staminibus exclusis) puberulis, sepalis brevioribus et latoribus ( $\pm 1.4$  mm longis), staminibus 4–8 calcaribus angustioribus differt. Figura 9O–R.

TYPE.—Western Cape, 3321 (Ladismith): Klein Swartberg, Seweweekspoort peak, 7500 ft [2 280 m], (–AD), 5-01-1981, *Vlok 139* (NBG).

This subspecies is distinguished from the typical subspecies in having leaves not quite as open-backed, all parts of the flower (excluding stamens) puberulous, shorter and broader sepals ( $\pm 1.4$  mm long) and 4–8 stamens with narrower appendages (Figure 9O–R).

*Flowering time*: December and January.

The subspecies has been recorded from the high altitudes of the eastern end of the Klein Swartberg Mountains just west of Seweweekspoort (Figure 7) where it has been recorded growing with *E. oreotragus*. It was first collected by two of the first group of botanical explorers of that rugged high area in December 1928, Andreae and Stokoe (Linder *et al.* 1993) (see also *E. taylorii* above). This area is about 40 kms west of the populations of subsp. *blaerioides*. Other than the peak just east of Seweweekspoort which we have investigated, the intervening mountain range has not to our knowledge ever been botanised. However, this range decreases in altitude down to the large Gamkaskloof and would therefore most probably not provide the type of high altitude, cool slopes required by the species.

#### Paratype material

##### subsp. *blaerioides*

WESTERN CAPE.—3321 (Ladismith): Oudtshoorn, Groot Swartberg, summit ridge above Kliphuisvlei, 1 900 m, (–BD), 1-01-1975, *Oliver 5529* (NBG, PRE); *ibid.*, 6500 ft [1 980 m], 17-01-1954, *Taylor 1087* (BOL).

##### subsp. *hirsuta*

WESTERN CAPE.—3321 (Ladismith): Klein Swartberg, Klein Swartberg Peak [?Seweweekspoortberg], 6700 ft [2 040 m], (–AD), 28-12-1928, *Andreae 1280* (BOL, PRE); *ibid.*, 6800 ft [2 070 m], 28-12-1928, *Stokoe 1768* (NBG, PRE), as *1768a* (BOL, PRE); Seweweekspoort Peak, (–AD), 12-1928, *Stokoe 6669* (BOL, K, PRE).

#### REFERENCES

- BOLUS, H. 1894. Contributions to the Flora of South Africa. 1. Ericaceae. *Journal of Botany* 1894: 234–290.
- GUTHRIE, F. & BOLUS, H. 1905. *Erica*. In W.T. Thistleton-Dyer, *Flora capensis* 4: 4–315.
- COMPTON, R.H. 1941. Plantae novae africanae. *Journal of South African Botany* 7: 193–195.
- DULFER, H. 1965. Revision der südafrikanischen Arten der Gattung *Erica* L. 2. *Annalen des Naturhistorischen Museums in Wien* 68: 25–177.
- LINDER, H.P., VLOK, J.H., MCDONALD, D.J., OLIVER, E.G.H., BOUCHER, C., VAN WYK, B.-E. & SCHUTTE, A. 1993. The high altitude flora and vegetation of the Cape Floristic Region, South Africa. *Opera Botanica* 121: 247–261.
- MCDONALD, D.J., BOUCHER, C., & OLIVER, E.G.H. 2000. Obituary: Hugh Colin Taylor (1925–1999). *Bothalia* 30: 115–119.
- OLIVER, E.G.H. & OLIVER, I.M. 1994. Studies in the Ericaceae (Ericaceae). XIV. Notes on the genus *Erica*. *Bothalia* 24: 25–30.
- OLIVER, E.G.H. & OLIVER, I.M. 1998a. *Erica schumannii*, a new mat-forming species from South Africa. *Yearbook of the Heather Society* 1998: 32–38.
- OLIVER, E.G.H. & OLIVER, I.M. 1998b. Three new species of *Erica* (Ericaceae) from South Africa. *Novon* 8: 267–274.
- OLIVER, E.G.H. & OLIVER, I.M. 2000. *Erica kirstenii*, a new rock-loving species from South Africa. *Yearbook of the Heather Society* 2000: 57–62.
- REBELO, A.G., SIEGFRIED, W.R. & OLIVER, E.G.H. 1985. Pollination syndromes of *Erica* species in the south-western Cape. *South African Journal of Botany* 51: 270–280.
- SCHUMANN, D. & KIRSTEN, G. 1992. *Ericas of South Africa*. Fernwood Press, Cape Town.



# Studies in the liverwort family Aneuraceae (Metzgeriales) from southern Africa. 1. The genus *Aneura* and its local representative

S.M. PEROLD\*

**Keywords:** Aneuraceae, *Aneura pinguis* (L.) Dumort., Aneuroideae, *Riccardia* Gray, southern Africa, taxonomic problems

## ABSTRACT

This is the first of several projected articles dealing with the southern African Aneuraceae H.Klinggr. The family is cosmopolitan and comprises two subfamilies, only one of which, the Aneuroideae, with two genera, *Aneura* Dumort. and *Riccardia* Gray, occurs locally. Because of the taxonomic problems associated with this family and the scarcity of fruiting material, only one taxon in the genus *Aneura*, *A. pinguis* (L.) Dumort., has so far been accepted in this treatment. This is not meant to imply, however, that *A. pseudopinguis* Herzog does not occur in southern Africa; only, that the specimens I have examined, all belong to *A. pinguis*. A description and illustrations of *A. pinguis*, together with a distribution map are provided.

## INTRODUCTION

One of the relatively smaller families within the order Metzgeriales, is the cosmopolitan Aneuraceae H.Klinggr. It is divided into two subfamilies, which together comprise only four genera, but more than 200 species worldwide. Only one subfamily, the Aneuroideae (Schuster 1992), with two genera, occurs in southern Africa: *Aneura* Dumort. with one locally, infrequently collected species, and the more common *Riccardia* Gray, with several species. These two hygrophilous genera are related. Initially, and up to the middle of the 20th century, they were treated as synonyms, 'sometimes using the former name and sometimes the latter, for the same taxon' (Grolle 1993).

The genera *Aneura* and *Riccardia* may be separated as follows:

### *Aneura*

Thalli prostrate, closely adherent to substrate, fleshy, bright green and with somewhat greasy lustre, robust, 2–4(–7) mm wide, ligulate; apices rounded or scarcely emarginate; branching subsimple, developing few lateral pinnae; oil bodies in cells numerous, clear and small, 2.5–7.5 µm diam.; in cross section thallus (9)10–15 (or more) cells thick medianly, thallus gradually becoming thinner toward undulate or plicate margins. Rhizoids restricted to median ventral surface. Gemmae absent in local species.

Dioicous; male branches with 2–4 irregular rows of antheridia; female branches rudimentary with inflorescences sessile and ventrally hidden in deep lateral notch, archegonia in 2 or more rows; shoot-calyptra large, clavate, rounded at summit, corona inconspicuous; seta thick, 9–16 cells diam.; capsule valves with thickenings along longitudinal walls of epidermal cells on both adaxial and abaxial surfaces; spores 18.0–27.5 µm diam.

### *Riccardia*

Thalli prostrate, rarely erect, pale to deep green, relatively delicate and narrow, 0.5–2.0 mm wide, linear to lingulate; apices emarginate, rounded or truncate; branching freely, mostly uni- to rarely multipinnate; oil bodies sometimes absent in epidermal cells, otherwise 1–3(4) per cell, brown or black, large, 7.5–20.0 × 5–9 µm, ovoid, spherical or ellipsoid; in cross section axis up to 9 cells thick, margins plane. Rhizoids scattered on ventral surface. Gemmae endogenously produced on dorsal surface of thallus and 2-celled.

Dioicous, autoicous or heteroicous; male branches lateral, linear, with 2 regular rows of antheridia in 2–8 pairs; female branches lateral, well developed, with 2 rows of archegonia; shoot-calyptra medium-sized, clavate or cylindrical, corona conspicuous; seta slender, 4 cells diam.; capsule valves with thickenings confined to adaxial faces of longitudinal radial walls of epidermal cells.

In both genera there is little anatomical differentiation, usually without any distinction between the wings and midrib or nerve (the epithet *Aneura*, signifies the absence of a nerve). Because of their simplicity in organization, there are few distinctive characters. Moreover, frequent variability, apparently environmentally induced, in those few features that are available, make them difficult to study. Taxonomically it is widely accepted that the Aneuraceae is one of the most troublesome families among the Hepaticae.

The long, narrow thalli of *Riccardia* species in particular, often grow in intricately intertwined, densely overlying mats, with more than one species sometimes being present. The branches are rather brittle, and unravelling and cleaning them for study needs to be done with care and is time-consuming. Sterile plants are of little value, as gametangial and sporophytic characters are necessary for the correct placing of specimens; unfortunately, they are frequently without sporophytes, although they may produce gametangia. Furthermore, as they soon disappear, the oil bodies in samples from fresh plants, that are preferably kept in a refrigerator at 5°–6°C, need to be

\* National Botanical Institute, Private Bag X101, 0001 Pretoria.  
MS. received: 2001-05-23.



photographed and studied as soon as possible after collection. Data from disintegrating oil bodies can be misleading.

It is also recommended that plants should be studied in cultivation.

Meenks (1987) is of the opinion that herbarium collections are often useless, particularly if they are more than 20 years old. Type specimens are, however, far older generally, yet one needs to study them to compare them with fresh, living collections, however difficult that may be.

#### HISTORICAL NOTES

The Aneuraceae have been relatively poorly studied in southern Africa. Lehmann (1829) described our first new local taxon, *Aneura* (sub *Jungermannia*) *fastigiata*, collected by Ecklon on Devil's Peak and Table Mountain and compared it to *A.* (sub *J.*) *multifida*, which he also reported from Table Mountain, as well as two varieties of it. Gottsche *et al.* (1844–1847) accepted the presence of *A. fastigiata*, but compared it to *A. palmata*. They also briefly mentioned Ecklon's collections of *A. pinnatifida* and *A. multifida* from Promontorium Bonae Spei (Gottsche *et al.* 1844–1847: 788).

No further species were recorded from tropical or southern Africa (Jones 1956), until Stephani (1886) reported *R. pinguis* L. from S. Tomé. During 1890–1893 and 1917 Stephani described more than 20 new species from the African continent and the Mascareignes. Gola (1914) and Pearson (1922) each described one new species from Africa. Sim (1926) described no new species in his treatment, and only briefly mentioned *A. fastigiata* and *A. compacta*. Then, in 1952, S.W. Arnell described five new species from southern Africa. In 1963, he placed one of them, *R. submarginata*, in synonymy under the Brazilian species *R. pseudopinguis* Herzog (1942), although he had previously agreed with Jones (1956) that it was identical with *R. pinguis*. Jones (1956) was very conservative in his treatment of *Riccardia* species in tropical Africa. He placed some of Stephani's species in synonymy and made several new combinations, transferring four of Stephani's *Aneura* species to *Riccardia*, as the distinctions between the two genera had become generally accepted by then. Vanden Berghen (1972) reported the presence of *A. pseudopinguis* from Shaba, Kafubu and Lufira in Zaïre (Democratic Republic of Congo).

In 1981, Jones drew attention to an inversion of specific epithets that had occurred on the herbarium labels of the type specimens of *A. congoana* Steph. and *A. congoensis* Steph. Later, Jones & Harrington (1983) reported *R. angusticosta* and *R. limbata* from Sierra Leone and Ghana, as well as an unidentified *Riccardia* species from Ghana. Gradstein *et al.* (1983) announced the presence of *A. pseudopinguis* in West and East Africa, and in the same article Pócs transferred it from *Riccardia* to *Aneura*.

The last treatment of East African Aneuraceae was by Meenks & Pócs (1985), as a large number of unidentified

specimens and new information had accumulated in the meantime. Although they present a key to the African species of the family, and give extensive lists of specimens examined, literature records and distribution maps, only one species, *R. compacta*, is illustrated. Illustrations by Arnell (1952, 1963) are generally poor and Stephani's *Icones* (1985) are not freely available. Schuster (1992) remarked, with some justification, that African taxa of the Aneuraceae remain poorly known, as Arnell's treatment is far from satisfactory.

It is accordingly considered necessary to revise at least the southern African members of the Aneuraceae, which often represent southern extensions of range, and to give good illustrations wherever possible. This publication is the first in a series of projected papers on the local Aneuraceae.

#### METHODS AND MATERIAL STUDIED

With some exceptions, the same methodology as was employed in my treatment of southern African *Fossombronina* species (Perold 1997), is followed here: 1, samples of field-collected specimens were fixed in FAA on the day of collection; 2, more samples were selected for oil body study and cultivation and initially kept at 5°–6°C in transparent screw boxes, lined with damp filter paper; and 3, the rest of the specimens, destined to be held in the herbarium, were allowed to air-dry rapidly. Only traditional morphological-anatomical and histological methods were employed. Far less extensive use of the SEM was made in this study, however, as the spores of our local *Riccardia* species do not display marked differences in their ornamentation. The drawings were based on photographs taken with a camera mounted on a Nikon light microscope. The Degree Reference System (Edwards & Leistner 1971) was again used for recording distribution data.

#### *Specimens examined*

(held at PRE, unless otherwise indicated)

S.W. Arnell 1552, 1766 (types of *R. submarginata* BOL); 1782 (BOL); 1803, 1844 (S).

Burgoyne 2462.

Cholnoky s.n. (S) KwaZulu-Natal; grid unknown and not indicated on Figure 2.

Koekemoer 2063.

Perold 3774, 3823. Perold & Koekemoer 4304, 4483, 4504, 4514.

**Aneuraceae** *H.Klinggr.*, Die höheren Cryptogamen Preussens: 11 (1858); Müll.Frib.: 492 (1951–1958); S.W.Arnell: 84 (1963); Furuki: 306 (1991); R.M.Schust.: 545 (1992); Paton: 537 (1999); Bednarek-Ochyra *et al.*: 178 (2000). Type: *Aneura* Dumort.

Plants thalloid, prostrate or sometimes ascending, bright green with greasy lustre or light to dark green, robust and fleshy, lingulate to sublinear, 2–4(–6) mm wide or narrow and thin, relatively delicate, mostly linear, 0.5–2.0 mm wide, apices rounded or emarginate, margins undulate, sometimes flat or plane and entire. *Branching* virtually simple to sparse, branches laterally and irregularly lobed or freely pinnate to quadripinnate,



occasionally crowded. *Dorsal epidermal cells* generally somewhat smaller than internal cells, not otherwise differentiated, usually thin-walled, occasionally with minute trigones, 5–7-angled. *Oil bodies* in each cell, either numerous and then small and hyaline, or only 1–3(4), and then large, finely granular and brown or black, rarely absent. *Cross section* of main axis plano-convex to concavo-convex with weakly recurved margins, or flattened to biconvex; pluristratose medianly, usually 9–15 cells thick, gradually thinning out laterally to margins, acute, winged, or obtuse, without discrete midrib, internally homogeneous, lower cells sometimes with basidiomycete fungal hyphae. *Mucilage papillae* often in 2 alternate ventral rows, one on each side of midline and/or clustered at apex of thallus. *Rhizoids* restricted to ventral median area or scattered over ventral surface of thallus. *Asexual reproduction* absent or by 2-celled, endogenously produced gemmae.

Dioicous, monoicous or synoicous. *Sexual branches* lateral from main thallus, short and determinate in length; male branches single or in sympodial pairs or in threes, antheridia in up to 4 irregular rows or in 2 regular rows of antheridial chambers, each containing a single antheridium, dorsally exposed; female branches within deep lateral notch of thallus or almost sessile laterally, archegonia in 2 or more rows, protected by papilliform or finger-like paraphyses. *Shoot-calyptra* large, clavate or cylindrical, with wall several cell layers thick, surface almost smooth or bearing papillose outgrowths. *Seta* thick, 10–12 cells diam., or slender and only 4 cells diam. *Capsule* ellipsoidal, 4-valved, wall bistratose, outer cell layer with bands of thickening on adaxial and abaxial radial walls; inner cell layer with bands of thickening on adaxial and abaxial radial and inner tangential walls, or else, outer cell layer with bands of thickening on adaxial radial and inner tangential walls, without bands of thickening on inner cell layer. *Spores* relatively small, up to 27.5 µm diam., finely papillose, or only up to ± 20 µm diam., minutely scabrate. *Elaters* up to ± 350 µm long, uni-spiral, band reddish brown, 7.5–10.0 µm wide, tapering at both ends. *Elaterophores* in fascicles at apices of valves.

***Aneura* Dumort.**, Commentationes Botanicae: 115 (1822); Hewson: 184 (1970); Furuki: 308 (1991); R.M.Schust.: 551 (1992); Paton: 537 (1999). Type species: *Aneura pinguis* (L.) Dumort.

*Jungermannia pinguis* L.: 1136 (1753).

*Trichostylum* Corda: 116 (1835); Nees: 475 (1838); R.M.Schust.: 53 (1958).

*Riccardia* subgenus *Trichostylum* Mizut. & S.Hatt.: 35 (1957).

Thalli prostrate, clear green and greasy, robust, fleshy, dorsally flat or slightly concave, gradually thinning out from thick median region to margins, smooth, up to 35 mm long, 2–4(–6) mm wide, lingulate to sublinear, apices rounded or slightly emarginate, margins undulate, sometimes flat. *Branching* sparse and irregular. *Oil bodies* (2–)5–24(–67) in all dorsal epidermal and inner cells,

subglobose or ovoid, 2.5–5.0 µm diam., hyaline. *Cross section* of thallus (9)10–15 cells thick medianly, acute at margins. *Mucilage papillae* only on ventral surface of thallus, in 2 rows, one on each side of midline and clustered at branch apices. *Rhizoids* restricted to median area of ventral surface of thallus. *Asexual reproduction* absent, gemmae unknown in local species.

Dioicous. Heterothallic. *Male thalli* somewhat smaller, antheridial branches single or sympodially paired and antheridia in up to 4 irregular rows, separating walls usually bistratose, dorso-lateral wing up to 6 cells wide. *Female branches* shielded and hidden in deep, lateral notches of thallus, paraphyses around and between archegonia. *Shoot-calyptrae* large, ± 10 mm long, fleshy, wall ± 500 µm thick, corona inconspicuous. *Setae* massive, 10–12 cells diam., spirally twisted. *Capsules* ellipsoidal, 4-valved, bistratose, epidermal cells with nodular thickenings of both adaxial and abaxial radial longitudinal walls; inner cell walls with numerous annular or semiannular (tangential) bands. *Spores* finely papillose, 20.0–27.5 µm diam. *Elaters* up to 350 µm long, 10 µm wide, unispiral.

***Aneura pinguis* (L.) Dumort.**, Commentationes Botanicae: 115 (1822); Dumort.: 86 (1831); Gottsche et al.: 493 (1844–1847); Steph.: 762/272 (1899); Müll.Frib.: 331 (1908); Brown & Braggins (with question mark): 117 (1989); Furuki: 311 (1991); R.M.Schust.: 555 (1992); Paton: 539 (1999). *Jungermannia pinguis* L.: 1136 (1753). *Riccardia pinguis* (L.) Gray: 683 (1821); Müll.Frib.: 494 (1951–1958); S.W.Arnell: 30 (1956); E.W.Jones: 84 (1956). *Trichostylum pinguis* R.M.Schust.: 53 (1958). Type: 'Habitat in Europae paludibus', sin. coll., Dill. in 'Historia Muscorum: 509. Lichenastrum no. 42, t. 74, fig. 42 (1741)' [OXF, syn.: H-SOL, isosyn.].

*R. viridissima* Schiffn.: 176 (1898). *A. viridissima* (Schiffn.) Steph.: 763/273 (1899). Type: Java, Prov. Batavia, in monte Megamendon, Schiffner 235, syntype (JE, L, PR, PRC, W), fide Furuki 1991.

*A. laurentiana* Steph.: 32 (1917). *R. laurentiana* (Steph.) Demaret: 306 (1942). Type: Congo, env. d'Eala, Laurent 64 (G).

*R. submarginata* S.W.Arnell: 139 (1952). Types: Deepwall Forest Reserve, 1/2 mile south of Forest Station, S.W. Arnell 1552, 1766 (BOL.; S).

A complete list of synonyms is provided in R.M. Schuster (1992: 555, 556).

Thalli prostrate, in patches, bright green, with greasy lustre, smooth, yellow when dried, opaque, becoming translucent toward margins, otherwise fleshy, robust, axis plane to slightly concave, subsimple, lingulate to sublinear, 15–35 mm long, 2–6(–7) mm wide, apices rounded, margins entire, undulate to somewhat crisped or lobed. *Branching* sparse, not pinnate, often short, sometimes long, irregularly furcate. *Dorsal epidermal cells* (Figure 1H) from above, 4–6(7)-sided, thin-walled, 50.0–87.5 × 37.5–62.5 µm; subdorsal cells (Figure 1I) 112.5–175.0 × 87.5–132.5 µm; subventral cells 100–160 × 50–75 µm; ventral epidermal cells 62.5–100.0 × 37.5–50.0 µm. *Oil bodies* in all cells, several to numerous, (2–)5–24(–67), small, 2.5–5.0 µm diam., spherical to subspherical or ovoid, faintly granular, inconspicuous,

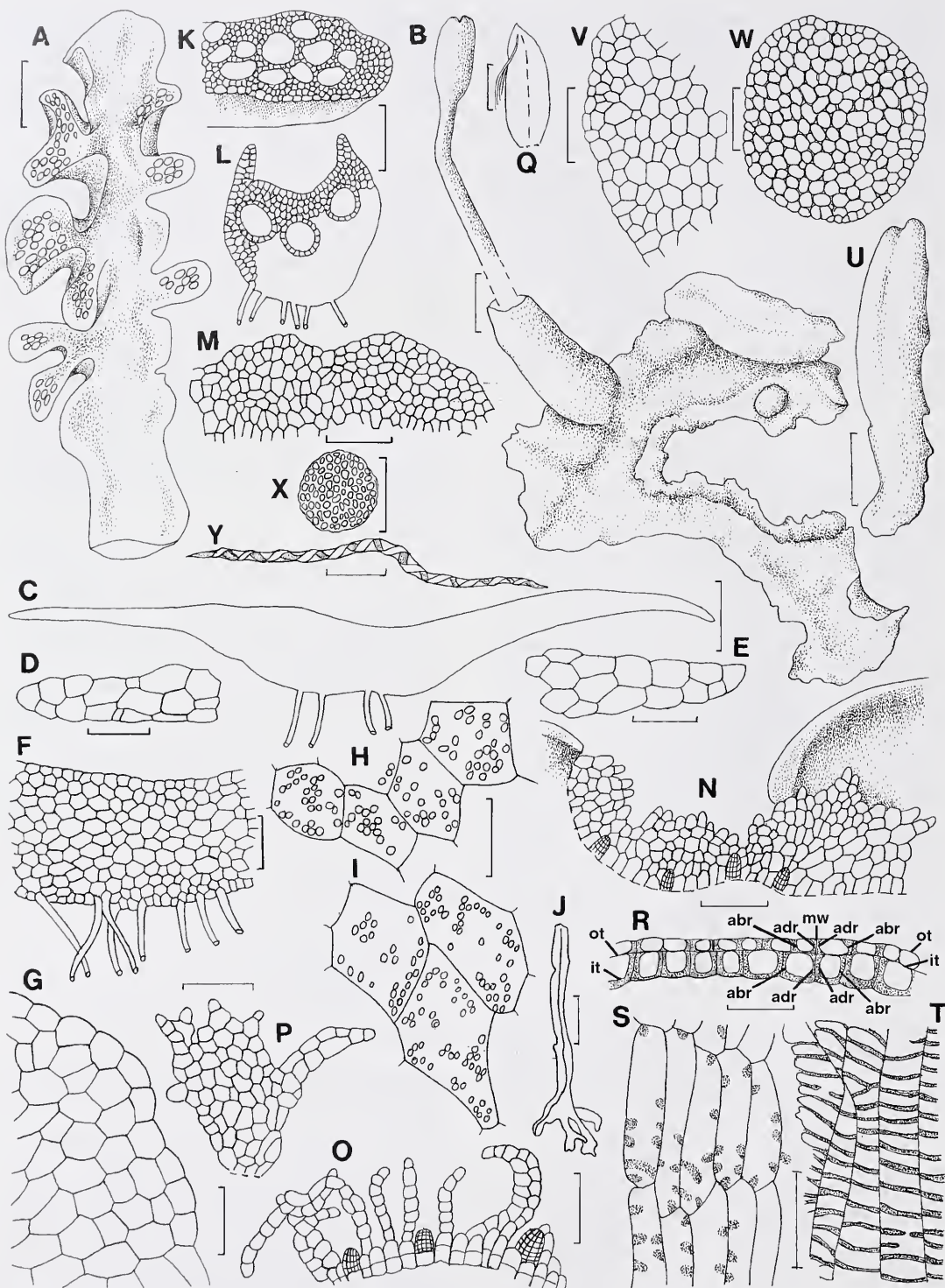


FIGURE 1.—*Ancura pinguis*. A, male thallus with antheridial branches; B, female thallus with calyptra, shortened seta and capsule, old, collapsed calyptra on upper right, very young calyptra opposite it. C–I, thallus: C, c/s; D, E, c/s marginal part; F, c/s median part; G, margin from above; H, dorsal epidermal cells with oil bodies; I, subdorsal cells with oil bodies. J, rhizoid with ramified tip and internal mycorrhizal hypha. K–M, male branches: K, partly from side, only one wing shown; L, c/s; M, wing. N, O, young female branches: N, ventral view, located at notch in thallus margin; O, lateral view. P, paraphysis. Q–T, capsule: Q, valve with elaterophore at tip. R, c/s part of bistratose wall, with thickenings: abr, abaxial radial; adr, adaxial radial; mw, median; it, inner tangential; ot, outer tangential. S, thickenings of outer cell layer; T, thickenings of inner cell layer. U, calyptra; V, c/s calyptra; W, c/s seta; X, spore; Y, elater. A, B, N, S, T, W–Y, *Perold & Koekemoer* 4504; C, D, F, H, I, K–M, O–R, U, V, *Perold & Koekemoer* 4514; E, G, *Perold & Koekemoer* 4483; J, *Perold* 3823. Scale bars: A, B, U, 2 mm; C, K, L, 500 µm; D, E, G, J, S, T, 100 µm; H, I, R, Y, 50 µm; Q, 1 mm; F, M–P, V, W, 250 µm; X, 25 µm.



colourless, scattered or occasionally aggregated in clusters. *Marginal cells* (Figure 1G): outermost row unistratose, rectangular,  $47.5\text{--}75.0 \times 25\text{--}45 \mu\text{m}$ , inner cells angular, bistratose,  $42.5\text{--}55.0 \times 37.5\text{--}62.5 \mu\text{m}$ . *Cross section* of thallus (Figure 1C) plano-convex to concavo-convex, with wings weakly recurved, medianly pluristratose (Figure 1F), 9–15 cells (or  $460\text{--}650 \mu\text{m}$ ) thick, gradually becoming thinner laterally, epidermal cells chlorophyllose,  $37.5\text{--}50.0 \mu\text{m}$  high, shallower than internal, hyaline cells, but not forming a distinctive layer; margins acute, bordered by bistratose wing, 3 cells wide plus a single conical cell (Figure 1D, E),  $\pm 50 \mu\text{m}$  high. *Mucilage papillae* clustered at ventral apices of branches and spaced along 2 rows, one on each side of midline, clavate,  $105\text{--}114 \times 42.5\text{--}51.0 \mu\text{m}$ , not persistent. *Rhizoids* restricted to ventral median area,  $17.5\text{--}25.0 \mu\text{m}$  wide, sometimes ramified at tips and occasionally with mycorrhizal hyphae (Figure 1J). *Asexual reproduction* by gemmae absent.

*Diocious. Male plants* (Figure 1A) somewhat smaller than female plants, axis up to  $17 \times 3.5\text{--}4.2 \text{ mm}$  and medianly 9–11 cell layers thick, in close proximity to female plants, virtually touching; antheridial branches (Figure 1K) lateral, solitary, sublinear, 2.8 mm long or more,  $\pm 1.15 \text{ mm}$  wide and  $\pm 850 \mu\text{m}$  thick (Figure 1L), scalloped, bistratose wings (Figure 1M),  $300\text{--}500 \mu\text{m}$  or 6–8 cells wide, a continuation of thallus margin; otherwise divided into 2 or 3 branches, from near base or further along, up to 2.4 mm wide, antheridial chambers very irregularly arranged, not in rows, 2–4 across width of branch; antheridia subglobular,  $200\text{--}250 \mu\text{m}$  wide, cavity walls between them bistratose; after antheridial production, branch may continue vegetative growth. *Female plants* (Figure 1B) with archegonial branches very short, ventral to lateral notch in thallus margin, at base of deep sinus and obscured by reflexed thallus folds on each side (Figure 1N), archegonia in rows, hidden by densely crowded paraphyses, up to  $\pm 500 \mu\text{m}$  long, composed of single strands of cells joined end to end (Figure 1O) or partly of 3 or more rows of laterally joined cells (Figure 1P). *Calyptra* clavate, large (Figure 1U),  $10\text{--}12 \text{ mm}$  long,  $\pm 2 \text{ mm}$  diam., wall 8 or 9 cell layers ( $\pm 500 \mu\text{m}$ ) thick, cells in cross section (Figure 1V) 5–7-sided,  $65\text{--}100 \times 62.5\text{--}75.0 \mu\text{m}$ , outermost cells of wall in surface view long-rectangular,  $150\text{--}170 \times 60\text{--}75 \mu\text{m}$ , in lower part of calyptra often developing rhizoids, but becoming nearly smooth with age, corona inconspicuous, base partly sheathed by adjacent, suberect thallus margins. *Seta* up to 21 mm long, somewhat spirally twisted,  $750 \mu\text{m}$  or 15 cells diam. in cross section (Figure 1W), marginal cells small,  $32.5\text{--}47.5 \times 25\text{--}40 \mu\text{m}$ , inner cells round,  $55\text{--}75 \mu\text{m}$  diam. *Capsules* oblong-ovoid, reddish brown,  $2500\text{--}3250 \mu\text{m}$  long, with 4 valves, each one  $\pm 1050 \mu\text{m}$  (or  $\pm 42$  cells) wide, bistratose, to either side of midline of every valve, thickenings laid down as a mirror image; epidermal (outer) cells in external longitudinal view (Figure 1S) with nodular thickenings, cells usually narrowly rectangular,  $162.5\text{--}232.5 \times 15.0\text{--}37.5 \mu\text{m}$ , in cross section (Figure 1R), thickenings only rarely extending slightly across outer tangential walls, mostly on adaxial radial and abaxial radial walls; inner cells in internal longitudinal view (Figure 1T) less regular, tapering or with oblique end walls,  $142.5\text{--}220.0 \times 32.5\text{--}67.5 \mu\text{m}$ , in cross section (Figure 1R) adaxial radial longitudi-

nal walls all develop bands which extend across inner tangential walls and connect with abaxial radial bands on opposite side of cell, thickenings therefore  $\pm$  U-shaped (Figure 1R). *Spores*  $20.0\text{--}27.5 \mu\text{m}$  diam., dark brown, papillose (Figure 1X). *Elaters* (Figure 1Y)  $212.5\text{--}350.0 \times 10 \mu\text{m}$ , with single spiral band,  $\pm 10 \mu\text{m}$  broad, pinkish red, tapering to ends, these without spiral. *Elatrophores*  $1000\text{--}1445 \times 220 \mu\text{m}$ , one at tip of each valve (Figure 1Q). *Chromosome no.:*  $n = 10$  (Fritsch 1982).

*Aneura pinguis* is subcosmopolitan in its distribution and has been reported from many localities worldwide; South America and Australia are, however, excluded. It is also present in southern Africa, but is infrequently collected (Figure 2). It grows on soil or rotting wood, in permanently damp areas, often fed by seepages.

## DISCUSSION

*Aneura* specimens have recently been collected at a few localities in Mpumalanga, Eastern Free State, KwaZulu-Natal, Western and Eastern Cape, but *Perold & Koekemoer 4405 & 4415* from Garcia's Pass, near Ladismith in Western Cape, are the only specimens that are fertile, with both mature male plants bearing ripe antheridia on lateral branches, as well as female plants with calyptae and ripe capsules. Samples of these have been preserved in FAA for future reference. These specimens have been referred to *Aneura pinguis* because of the following characters: 1, the large, bright green, rather greasy-looking, fleshy and opaque thalli; 2, thalli in cross section medianly up to 15 cell rows thick; 3, each cell with several to many minute, colourless oil bodies; 4, 2–4 rows of antheridial chambers; 5, spores that are  $20.0\text{--}27.5 \mu\text{m}$  diam. On one side of the same male thallus of *Perold & Koekemoer 4514*, there are a few short, ligulate male branches, bearing the antheridia in 2 or 3 rows, whereas on its opposite side, there are several furcate male branches, some of which are wider and rounder at the apices, with up to 4 irregular rows of numerous antheridia.

Meenks & Pócs (1985) have drawn up a short table differentiating between *A. pinguis* and *A. pseudopinguis*,

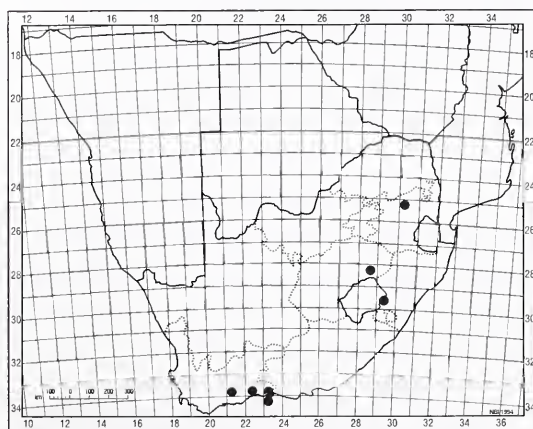


FIGURE 2.—Distribution of *Aneura pinguis* in southern Africa.



but there appears to be some overlap in the characters assigned to these two species in our local specimens. Meenks & Pócs regard *A. pinguis* as having opaque thalli, medianly (9)10–20 cells thick, with relatively short male lobes, which seldom branch and contain 2–5(6) pairs of antheridia; the spores are 20–25 µm diam. On the other hand, *A. pseudopinguis* thalli are, according to them, translucent, medianly only 5–8(9) cells thick, the male branches are longer, often with 3 (seldom 4) rows or 7–10(–20) pairs of antheridia, and the spores are 13–16 µm diam.

In the specimens they studied, Gradstein *et al.* (1983) regarded the identity as confirmed in ‘only the records of plants possessing either male branches or spores’. They also report that in African samples of *A. pseudopinguis* ‘usually only one sex is found in a particular locality’. This is contrary to the findings in our two fertile collections referred to above, and may provide further evidence that we are dealing with *A. pinguis*.

In 1952 Arnell reported his new *Riccardia submarginata* from Deepwall Forest Reserve. There were no mature capsules with spores, but the median cross sections of the thalli were given as 15 cell rows thick. In my examination of Arnell’s specimens the median cross sections of the thalli ranged from 8–13 cell rows thick.

As already remarked in the paragraphs on ‘Historical notes’, Arnell had admitted to Jones (1956) that, the Deepwall specimens were identical to *R. pinguis*, although later, Arnell (1963) placed *R. submarginata* in synonymy under *R. pseudopinguis*. Arnell was familiar with European representatives of *R. pinguis*, as he had described it in 1956 in his *Flora Fennoscandia*. Arnell (1963) also gave vegetative characters, based on the size of the thallus cells in *R. pinguis*, but these characters appear to be in contradiction with his own account of Scandinavian *A. pinguis*, as noted by Gradstein *et al.* (1983).

Vanden Berghen (1972) reported the Congolan presence of *A. pseudopinguis* from Shaba, Kafubu in Lufira. Hodgetts *et al.* (1999) also reported *A. pseudopinguis* from Lesotho, northeast and west of New Oxbow Lodge, but gave no details of their plants. Herzog (1942) described his new species, *R. pseudopinguis*, from Brazil as follows: thallus is medianly 6–8 cells thick in cross section, male branches are elongated, ligulate, sometimes furcate at the base, and the antheridia are in 8–10 serial pairs, whereas the spores are 13–16 µm in diameter. He suggested that previous collections from neighbouring areas, which had been assigned to *R. pinguis*, should be checked against his new species. In 1956, Jones placed *R. submarginata* in synonymy under *R. pinguis*. In his plants from West Africa, however, the central portion of the thallus is 5–7 or occasionally 9 cells thick, which would place them nearer to *A. pseudopinguis*. Wigginton & Grolle (1996) observed that, ‘*A. pseudopinguis* is sometimes considered to be conspecific with *A. pinguis*’. Schuster (1989) noted that, ‘The status of *A. pinguis* s. lat. badly needs world-wide study. Ever since Showalter (1926, 1928) showed that, so-called ‘races’ of the holarctic populations were, in some cases intersterile, the matter of how to define this species has been

highly uncertain’. Furthermore, it seemed most unlikely to Schuster that a species could occur in the Arctic polar desert of Ellesmere Island and also in tropical and subtropical areas. He concluded this paragraph with the following observation, ‘Recent study has also shown that the tropical American-African plants formerly referred to *A. pinguis* represent *A. pseudopinguis* Herz.’.

According to Meenks & Pócs (1985), however, both taxa occur in East Africa, as well as in West Africa (Gradstein *et al.* 1983), but *A. pinguis* appears to be rarer in tropical Africa than *A. pseudopinguis*. In southern Africa, *A. pinguis* is very infrequently collected and fertile plants are the exception by far, rather than the rule; this scarcity of fruiting material further complicates the study of these plants. To quote Proskauer (1971), ‘*Riccardia pinguis*, a species which we have long known to present a nightmarish problem ..., probably requiring more than a single lifetime of research for a minimum understanding’.

Stephani (1899) placed *R. latissima* (Spruce) Schiffn. in synonymy under *R. pinguis*. However, Meenks & De Jong (1985) note that, the oil bodies in *A. latissima* are bright brown, not clear and colourless, as they are in *A. pinguis*. Furthermore, a chromosome no.  $n = 8$ , has been reported by Nakata & Inoue (1989) for *A. latissima*, whereas the chromosome no.  $n = 10$  is given for *A. pinguis*. Stephani’s synonymy of *A. latissima* under *A. pinguis*, is, accordingly not accepted here.

#### ACKNOWLEDGEMENTS

I wish to thank the curators of BOL and S for the loan of specimens; the curator of PRE, Ms M. Koekemoer, for all her help with fieldwork; Dr T. Furuki and Dr O.A. Leistner for their helpful comments; the artist, Ms G. Condy; the photographer, Mrs A. Romanowski and the typist, Ms D. Maree.

#### REFERENCES

- ARNELL, S.W. 1952. Hepaticae collected in South and West Africa (1951). New and little-known species. *Botaniska Notiser* 105: 307–315.
- ARNELL, S.W. 1956. *Illustrated moss flora of Fennoscandia. I. Hepaticae*. Gleerup, Lund.
- ARNELL, S.W. 1963. *Hepaticae of South Africa*. Swedish Natural Science Council, Stockholm.
- BEDNAREK-UCHYRA, H., VÁNA, J., UCHYRA, R. & LEWIS SMITH, R.I. 2000. The liverwort flora of Antarctica. Polish Academy of Sciences, Institute of Botany, Cracow.
- BROWN, E.A. & BRAGGINS, J.E. 1989. A revision of the genus *Riccardia* S.F.Gray in New Zealand with notes on the genus *Aneura* Dum. *Journal of the Hattori Botanical Laboratory* 66: 1–132.
- CORDA, A.K.J. 1835. Deutschlands Jungermannien. In J. Sturm, *Deutschlands Flora nach der Natur mit Beschreibungen* 2,5/6: 116–121. Berlin.
- DEMARET, F. 1942. Prodrome des Bryophytes du Congo-Belge et du Ruanda-Burundi. II. Hepaticae. *Bulletin du Jardin Botanique de l’Etat à Bruxelles* 16: 306.
- DILLENIUS, J.J. 1741. *Historia muscorum*. Sheldon, Oxford.
- DUMORTIER, B.C. 1822. *Commentationes Botanicae*: 1–117. Tournay.
- DUMORTIER, B.C. 1831. *Sylloge Jungermanniicarum Europae indigenarum, earum genera et species systematice complectens*: 1–100. Tournay.

- EDWARDS, D. & LEISTNER, O.A. 1971. A degree reference system for citing biological records in southern Africa. *Mitteilungen der Botanischen Staatssammlung, München* 10: 501–509.
- FRITSCH, R. 1982. Index to plant chromosome numbers—Bryophyta. *Regnum Vegetabile* 108: 1–268.
- FURUKI, T. 1991. A taxonomical revision of the Aneuraceae (Hepaticae) of Japan. *Journal of the Hattori Botanical Laboratory* 70: 293–397.
- GOLA, G. 1914. Le epatiche della regione del Kenia. *Memorie della R. Accademia delle Scienze di Torino*, ser. 2, 65: 1–11.
- GOTTSCHE, C.M., LINDENBERG, J.B.G. & NEES AB ESENBECK, C.G. 1844–1847. *Synopsis hepaticarum*. Meissner, Hamburg. Reprinted 1967, Cramer, Lehre.
- GRADSTEIN, S.R., PÓCS, T. & VÁNA, J. 1983. Disjunct hepaticae in tropical America and Africa. *Acta Botanica Hungarica* 29: 127–171.
- GRAY, S.F. 1821. *A natural arrangement of British plants*, vol. 1. London.
- GROLLE, R. 1993. Proposal to conserve *Aneura* Dumort. (Hepaticae) with a conserved type. *Taxon* 42: 889, 890.
- HERZOG, T. 1942. Beiträge zur Kenntnis neotropischer Bryophyten. *Beihfte zum Botanischen Centralblatt*, Abt. B, 62: 560, 561.
- HEWSON, H.J. 1970. The family Aneuraceae in Australia and New Guinea: 1. The genus *Aneura*. *Proceedings of the Linnean Society of New South Wales* 94: 173–193.
- HODGETTS, N.G., MATCHAM, H.W. & DUCKETT, J.G. 1999. Bryophytes collected in Lesotho, the Natal Drakensberg and the Orange Free State, southern Africa. *Journal of Bryology* 21: 133–155.
- JONES, E.W. 1956. African hepatics XI. The genus *Riccardia* in tropical Africa. *Transactions of the British Bryological Society* 3: 74–84.
- JONES, E.W. 1981. African hepatics XXXII. Some little-known species and extensions of range. *Journal of Bryology* 11: 311–323.
- JONES, E.W. & HARRINGTON, A.J. 1983. The Hepaticae of Sierra Leone and Ghana. *Bulletin of the British Museum (Natural History)*, Botanical series, 11: 215–289.
- KLINGGRÄFF, VON, H.E.M. 1858. *Die höheren Cryptogamen Preussens. Ein Beitrag zur Flora der Provinz*. Koch, Königsberg.
- LEHMANN, J.G.C. 1829. Hepaticarum capensium a C.F. Ecklon collectarum brevem recensionem. *Linnaea* 4: 357–371.
- LINNAEUS, C. 1753. *Species plantarum*. Salvius, Stockholm.
- MEENKS, J.L.D. 1987. Studies on Colombian cryptogams XXVIII. A guide to the tropical Andean species of *Riccardia* (Hepaticae). *Journal of the Hattori Botanical Laboratory* 62: 161–182.
- MEENKS, J.L.D. & DE JONG, C. 1985. Light microscope studies of the oil bodies of Andean Aneuraceae (Hepaticae). *Cryptogamie, Bryologie, Lichénologie* 6: 1–24.
- MEENKS, J.L.D. & PÓCS, T. 1985. East African Bryophytes IX. Aneuraceae. *Abstracta Botanica* 9: 79–98.
- MIZUTANI, M. & HATTORI, S. 1957. An étude on the systematics of Japanese *Riccardias*. *Journal of the Hattori Botanical Laboratory* 18: 27–64.
- MÜLLER, K. (Müll.Frib.) 1905–1916. Die Lebermoose Deutschlands, Oesterreichs und der Schweiz. *Dr L. Rabenhorst's Kryptogamen-Flora* 2, edn 6, part 1: 1–870. Geest & Portig, Leipzig.
- MÜLLER, K. (Müll.Frib.) 1951–1958. Die Lebermoose Europas. *Dr L. Rabenhorst's Kryptogamen-Flora* 6, edn 3: 308–474. Geest & Portig, Leipzig.
- NAKATA, M. & INOUE, H. 1989. Further observations on chromosomes of *Aneura latissima* Spruce. *Bulletin of the Natural Science Museum, Tokyo*, ser. B, 15: 139–143.
- NEES AB ESENBECK, C.G. 1838. *Naturgeschichte der europäischen Lebermoose* 4: 1–540.
- PATON, J.A. 1999. *The liverwort flora of the British Isles*. Harley Books, Colchester.
- PEARSON, W.H. 1922. Notes on a collection of hepatics from the Cameroons, West Coast of Africa. *Memoirs and Proceedings of the Manchester Literary and Philosophical Society* 65: 1–6.
- PEROLD, S.M. 1997. Studies in the liverwort genus *Fossombronina* (Metzgeriales) from southern Africa. 1. Three new species from Northern Province, Gauteng and Mpumalanga. *Bothalia* 27: 17–27.
- PROSKAUER, J. 1971. Notes on Hepaticae. V. *Bryologist* 74: 1–9.
- SCHIFFNER, V. 1898. *Couspectus hepaticarum archipelagi indici*. Batavia.
- SCHUSTER, R.M. 1958. Keys to the orders, families and genera of Hepaticae of America north of Mexico. *The Bryologist* 61: 1–66.
- SCHUSTER, R.M. 1989. Studies on the hepatic flora of the Prince Edward Islands. 1. Aneuraceae. *Journal of the Hattori Botanical Laboratory* 67: 59–108.
- SCHUSTER, R.M. 1992. *The Hepaticae and Anthocerotae of North America* 5: 1–854. Field Museum of Natural History, Chicago.
- SHOWALTER, A.M. 1926. Studies in the cytology of the Anacrogynae. II. Fertilisation in *Riccardia pinguis*. *Annals of Botany* 40: 713–726.
- SHOWALTER, A.M. 1928. Studies in the cytology of the Anacrogynae. V. Hybrid fertilization in *Riccardia pinguis*. *La Cellule* 38: 295–348.
- SIM, T.R. 1926. The Bryophyta of South Africa. *Transactions of the Royal Society of South Africa* 15: 1–475. Cape Town.
- STEPHANI, F. 1886. Flora de S. Thomé. Hepaticae, in *Contribuciones para o estudo da Flora d'Africa. Boletim da Sociedade Brotariana, Coimbra* 4: 170–184.
- STEPHANI, F. 1890. Hepaticae Africanae novae in insulis Bourbon, Maurice et Madagascar lectae. *Botanical Gazette* 15: 281–292.
- STEPHANI, F. 1891. Hepaticae Africanae. *Hedwigia* 30: 265–274.
- STEPHANI, F. 1892. Hepaticae Africanae. *Hedwigia* 31: 198–214.
- STEPHANI, F. 1893. Hepaticae species novae. *Hedwigia* 32: 19, 23.
- STEPHANI, F. 1899. Species hepaticarum. *Bulletin de L'Herbier Boissier* 7: 762, 763.
- STEPHANI, F. 1917. Species hepaticarum, vol. VI: 19–46. Genève et Bale, Georg et Cie, Lyon (même maison).
- STEPHANI, F. 1985. *Icones hepaticarum*. Microfiche, Inter Documentation Company bv, Leiden.
- VANDEN BERGHEN, C. 1972. Hépatiques et Anthocérotes. In J.J. Symoens, *Résultats scientifiques. Exploration hydrobiologique du bassin du lac Bangweolo et du Luapula* 8,1.
- WIGGINGTON, M.J. & GROLLE, R. (Supplemented by GYARMATI, A.) 1996. Catalogue of the Hepaticae and Anthocerotae of sub-Saharan Africa. *Bryophytorum Bibliotheca* 50: 1–267. Cramer, Berlin.





## Three new species of *Tritoniopsis* (Iridaceae: Crocoideae) from the Cape Region of South Africa

J.C. MANNING\* and P. GOLDBLATT\*\*

**Keywords:** Iridaceae, new species, pollination, South Africa, taxonomy, *Tritoniopsis* L.Bolus, *T. bicolor* J.C.Manning & Goldblatt, *T. flava* J.C.Manning & Goldblatt, *T. toximontana* J.C.Manning & Goldblatt, Western Cape

### ABSTRACT

Three new species of the largely Western Cape genus *Tritoniopsis* L.Bolus are described, bringing the number of species in the genus to 24. *Tritoniopsis bicolor* and *T. flava* are newly discovered, narrow endemics of the Bredasdorp Mountains and the Kogelberg Biosphere Reserve, respectively, in the southwestern Cape. Both of these are areas of high local endemism. *T. toximontana*, known since at least 1965 but misunderstood, is restricted to the Gifberg–Matsikamma Mountain complex of northern Western Cape. Notes on the pollination biology of the species are provided.

### INTRODUCTION

The genus *Tritoniopsis* L.Bolus (Iridaceae: Crocoideae) is a near-endemic of the Cape Floristic Region (Goldblatt & Manning 2000a), with a single species, *T. caffra* (Ker Gawl. ex Baker) Goldblatt, extending eastwards to East London. The genus is a particularly characteristic member of the Cape Flora as almost all of the species are restricted to acidic, nutrient-poor soils derived from sandstones of the Cape system. Originally established to accommodate the single species *Tritoniopsis lesliei* L.Bolus (Bolus 1929), the genus was subsequently combined with *Exohebea* Foster (Phillips 1951; Lewis 1959), and finally expanded to include the species previously placed in *Anapalina* N.E.Br. (Goldblatt 1990). The 21 species currently recognised exhibit a wide diversity in floral morphology but are united by several highly unusual characters. The leaves of *Tritoniopsis*, which are hysteranthous in all species, are unlike most other genera of Iridaceae subfamily Crocoideae (Goldblatt *et al.* 2000) in lacking a well-developed pseudomidrib or central vein, having instead one to seven equally prominent main veins. Flowering in most species is delayed until summer or autumn, and although green leaves are often evident at flowering time, these sometimes represent vegetative growth derived from the daughter corm. The contemporary appearance of leaves and flowering shoots from successive generations is unknown among hysteranthous Iridaceae and is correlated with the persistence of corms from previous years' growth and the late flowering habit. In other hysteranthous taxa of Iridaceae, leafing of the daughter corm typically occurs only after the flowering shoot of the parent corm has died down. Alternatively, as in some species of *Gladiolus* L., leaves are produced on a separate sterile shoot later in the season. *Tritoniopsis* is also unusual in having the inner floral bracts longer than the outer and not evidently notched at the apices. The flowers, although highly diverse in form, are always strongly

herkogamous. This spatial separation of pollen and style is achieved through the recurving of the filaments a few days after anthesis, whereby they carry the anthers well away from the style, the branches of which only become receptive after the filaments have diverged. This characteristic, noted by Lewis (1960) in her revision of the species placed in *Anapalina*, was apparently overlooked in her earlier account of *Tritoniopsis* s.s. (Lewis 1959) but is characteristic of all species of the genus. Another distinctive characteristic of most of the species is the way in which the tepals gape at the tips in bud, several days before anthesis actually occurs. This feature has not been commented on before and is otherwise unknown in the family. Finally, the seeds of almost all species of *Tritoniopsis* are tetrahedral or pyramidal in shape and typically more or less winged on the angles. Species in which the seeds are larger and more prominently winged invariably produce much-inflated capsules. This range of autapomorphies accord with indications that the genus is taxonomically isolated within subfamily Crocoideae. Several of the species have restricted ranges and the three described here are no exception. One species, *T. toximontana*, appears to be restricted to the Gifberg and Matsikamma massif, while *T. bicolor* and *T. flava* are each known from single populations in the Bredasdorp Mountains and Kogelberg Biosphere Reserve in the southwestern Cape respectively. Both of these are areas of high local endemism (Goldblatt & Manning 2000a).

***Tritoniopsis bicolor* J.C.Manning & Goldblatt**, sp. nov., plantae 200–400(–600) mm altae usitate eramosae, cormo globoso 20–30 mm diam. tunicis fibris brunneis dense implexis conferto, foliis 5–9 inferioribus (4)5–7 basalibus viridis vel externis siccis ad tempore floredi in pseudopetiolum subteretem 30–35 mm longum infime abrupte contractis, lamina anguste lanceolata (85–)100–150 × (5–)6–10 mm prominente 1–2(3)-nervata, foliis caulinis 1 vel 2 subsquamosis, spica 20–35-flora, bracteis infime viridibus superne siccis brunneisque, externa 7–10 mm longa acuta, interna 8–11 mm longa obtusa, floribus zygomorphis moschatis vel pungentibus odoris flavis tepalibus tribus infernis marroninus suffusis in medio atrostriatis ore tubi et basibus tepalarum minute papillosis, perianthii tubo 2–5 mm longo, tepalis inaequalibus marginibus undulato-

\* Compton Herbarium, National Botanical Institute, Private Bag X7, Claremont 7735, Cape Town.

\*\* B.A. Krukoff Curator of African Botany, Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri 63166, USA.

MS. received: 2001-03-07.

crispis dorsale 14–16 × 3–4 mm inferioribus tribus 9–15 mm infernis connatis laminis 9–10 mm longis, filamentis 6–7 mm longis, antheris ± 3 mm longis apiculis ± 0.5 mm longis ferentibus, styli ramis ± 1 mm longis.

TYPE.—Western Cape, 3419 (Caledon): western end of Bredasdorp Mtn, plateau west of Grootkop and Normanskop, (–BD), 6 Dec. 2000, *Manning* 2286 (NBG, holo.; K, MO, NBG, PRE, iso.).



FIGURE 1.—*Tritoniopsis bicolor*. A, corm; B, flowering spike and leaves. C–E, flower: C, front view; D, side view; E, half flower. F, capsules; G, seed. Scale bars: A–F, 10 mm; G, 10 mm. Artist: John Manning.

Plants 200–400(–600) mm high. *Corms* globose, 20–30 mm diam., tunics of densely matted fine brown fibres with well-developed neck, corms from previous seasons persistent. *Leaves* 5–9, lower (4)5–7 basal, green at flowering or the outermost drying, contracted abruptly into semiterete pseudopetiole 30–35 × 1.0–2.5 mm, blade narrowly lanceolate, acuminate, with 1 or 2(3) main veins, (85–)100–150 × (5)6–10 mm, cauline leaves evidently 1 or 2, represented by minute scales, lower cauline leaf concealed by fibrous corm neck. *Stem* moderately slender to robust, decurved just above ground level neck and then suberect or weakly inclined, unbranched, 2.5–4.0 mm diam. near base. *Spike* densely 20–35-flowered, 80–100(–150) mm long; bracts green at base but dry and brown above, leathery, oblong, outer bracts 7–10 mm long, acute, inner bracts 8–11 mm long, obtuse. *Flowers* zygomorphic, yellow, three lower tepals each flushed maroon in lower half and with darker median streak, producing strong, acrid or musty scent; perianth tube 2–5 mm long; tepals unequal, dorsal slightly larger, margins crisped or undulate, base of lower tepals and mouth of tube minutely papillate, dorsal tepal ascending and erect to slightly recurved above, narrowly oblanceolate, obtuse, 14–16 × 3–4 mm, upper laterals spreading horizontally, strongly clawed and recurved above, claw involute, 2–4 mm long, blade oblanceolate to obovate, obtuse, 7–9 × 2–3 mm, lower 3 tepals fused to one another for 1.0–1.5 mm, with or without short, channelled claw to 1.5 mm long, blade oblong, truncate, 9–10 × 2.0–4.5 mm. *Filaments* arcuate but later erect, 6–7 mm long, base of median filament minutely papillate; anthers yellow, 3 mm long with short apiculus 0.5 mm long. *Ovary* ellipsoid, ± 4 mm long; style ± 9 mm long, dividing opposite anther bases, branches ultimately 1 mm long. *Capsule* ovoid to broadly ellipsoid, inflated, 23–28 mm long. *Seeds* tetrahedral, 10–12 × 10 mm, reddish brown, winged on angles and conspicuously crested on faces. *Flowering time*: December. Figure 1.

*Distribution and biology*: *Tritoniopsis bicolor* has been collected only once from the Bredasdorp Mountains on the summit plateau west of Normanskop (Figure 2), flowering in the late spring after a fire the previous summer. The plants are restricted to seasonally waterlogged flats where they are fairly common growing in deep, humus-enriched sands. The smaller, cream-flowered species, *T. unguicularis* (Lam.) G.J.Lewis, occupies the adjacent drier, rocky slopes and the occasional hybrid plant was recorded at the interface between the populations. A few plants of *T. parviflora* (Jacq.) G.J.Lewis were found in fruit within a few hundred metres of the locality, also on drier slopes. Several individuals of the solitary bee *Amegilla spilotoma* (Apidae: Anthophorinae) were seen and captured while they visited flowers of *T. bicolor*.

*History*: this species was brought to our attention by a local botanist, Nick Helme, who collected it during a survey of portion of the Farm Pofadderskloof.

*Diagnosis and relationships*: *T. bicolor* is most likely to be confused with *T. parviflora* and the two are clearly closely related. The flowers in both species are moderately-sized with a musky to acrid scent and are coloured bright yellow with the lower tepals prominently marked

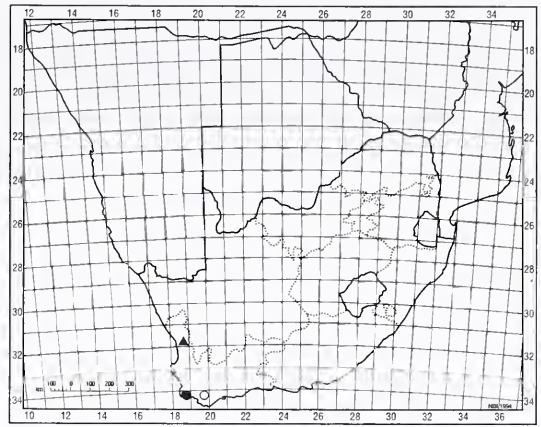


FIGURE 2.—Distribution of *Tritoniopsis bicolor*, ○; *T. flava*, ●; and *T. toximontana*, ▲, in Western Cape.

and flushed with maroon; the floral tube in both species is very short; the base of the tepals and mouth of the tube are minutely papillate; and the capsules of both species are conspicuously inflated. *Tritoniopsis parviflora* differs in its more prominently bilabiate flowers in which the lower three tepals are joined together in a distinct palate, 3–4 mm long, and in its much longer filaments, 12–14 mm long, that arch well over the lower lip. In *T. bicolor* the lower tepals are joined together for 1.0–1.5 mm without forming a well-defined lower lip and the anthers are held much closer to the mouth of the tube on short filaments 6–7 mm long. *Tritoniopsis bicolor* is distinctive in its leaves, which have a conspicuous semiterete pseudopetiole, 30–35 mm long, expanding abruptly into a narrowly lanceolate blade, 6–10 mm wide. The leaves of *T. parviflora* are linear or linear-lanceolate, 2–5 mm wide and although narrowed below are not contracted into a distinct pseudopetiole. The seeds of *T. bicolor*, measuring 10–12 mm long, also seem to be slightly larger than those of *T. parviflora*, which never exceed 9 mm in length.

Both species are restricted to acidic soils derived from sandstone rocks of the Table Mountain Series and although they both appear to flower only after a burn, they differ markedly in other aspects of their ecology and pollination biology. *Tritoniopsis parviflora* is widespread on dry, stony slopes in shallow sandy soils, from Citrusdal in the north to Bredasdorp in the south. It is unique among African Iridaceae in secreting floral oils from epithelial elaiophores on the perianth. Oil secretion is an adaptation to pollination by the large oil-collecting bee *Rediviva gigas* (Mellittidae) (Manning & Goldblatt in press) which has been captured while visiting and pollinating flowers of *T. parviflora*. *Tritoniopsis bicolor*, however, is restricted to a seasonally waterlogged site on the plateau of the Bredasdorp Mountains where it grows in deep, humus-enriched sands (pH 4.5). It is pollinated by the nectar-collecting bee *Amegilla spilotoma*. *T. bicolor* is evidently a local segregate of *T. parviflora* that has speciated on the specialised, seepage habitat on the Bredasdorp Mts at the extreme southern limits of the range of *T. parviflora*. The papillae on the palate and mouth of the tube that characterise both *T. bicolor* and *T. parviflora* are unique in the genus and are a significant synapomorphy for them. While the papillae are function-



al in oil secretion in *T. parviflora*, tests for floral oils in *T. bicolor* proved negative or at most equivocal. This suggests that the secretory function of the papillae has been suppressed in *T. bicolor* and that they remain as vestiges of an evolutionary origin from *T. parviflora*. It is possibly significant in this context that *Rediviva gigas* is not known from south of Kleinmond (Whitehead & Steiner 1993) and is therefore apparently absent from the Bredasdorp Mts. A few plants of *T. parviflora* with well-developed fruits were, however, collected within a few hundred metres of the population of *T. bicolor* indicating that a pollinating agent was active at the locality. Given the similarity in floral form between the two species it is likely that *Amegilla spilostoma* visits both species, but the difference in flowering time between the two at this locality prevents any possible hybridization.

***Tritoniopsis flava* J.C.Manning & Goldblatt**, sp. nov., plantae 500–600 mm altae eramosae, cormo globoso 20–35 mm diam. tunicis fibris rubro-brunneis dense implexis, foliis 10, inferioribus 7 basalibus viridis ad tempore flore di in pseudopetiolium complanatum infime contractis, lamina anguste lanceolata 130–190 × (3–)5–8 mm prominente 2–3-nervata, foliis caulinis 3 supernis duobus squamosis inferno ad 60 mm longo vaginante, spica ± 25-flora, bracteis ovatis obtusis viridibus infime siccis brunneisque superne, externa 6–9 mm longa, interna 7–10 mm longa, floribus zygomorphis probabiliter odoris flavis tepalibus tribus inferis pallide flavis in medio maroninus striatis, perianthii tubo 4–5 mm longo, tepalis inaequalibus anguste unguiculatis dorsale 15–16 × 6 mm oblanceolato infime perangusto inferioribus tribus ± 2.5 mm connatis infime laminis ± 10 × 6 mm, filamentis ± 10 mm longis, antheris ± 5 mm longis apiculis ± 0.5 mm longis ferentibus, styli ramis ± 1 mm longis ad apicem dilatatis.

TYPE.—Western Cape, 3418 (Simonstown): Kogelberg State Forest, along footpath and next to stream, (–BD), 10 Dec. 1991, Kruger 147 (NBG, holo.).

Plants 500–600 mm high. *Corms* globose, 20–35 mm diam., tunics of densely matted reddish brown fibres with short neck. *Leaves* 10, lower 7 basal, green at flowering, narrowed into flattened pseudopetiole below, blade narrowly lanceolate, 130–190 × (3–)5–8 mm, acuminate, with 2 or 3 main veins, cauline leaves 3 but upper 2 scarcely evident and represented by minute scales, lowermost reddish brown, lanceolate, up to 60 mm long, clasping throughout. *Stem* robust, decurved slightly just above ground level, unbranched, 4–5 mm diam. near base. *Spike* densely ± 25-flowered, 150–180 mm long; bracts green at base but dry and brown above, rigid and leathery but papery along margins, ovate, outer bracts 6–9 mm long, obtuse, inner bracts 7–10 mm long, obtuse. *Flowers* zygomorphic, yellow, three lower tepals each paler towards base with small maroon median streak in lower third; perianth tube slightly curved and widening to throat, 4–5 mm long; tepals unequal, dorsal slightly larger, oblanceolate and strongly narrowed in lower third, obtuse, 15–16 × 6 mm, upper laterals clawed, claw channelled, 5 mm long, blade obovate, obtuse, 8–9 × 5 mm, lower 3 tepals fused to one another for ± 2.5 mm, strongly clawed, claws channelled, 2 mm long, blades obovate-pandurate, truncate, ± 10 × 6 mm.

*Filaments* arcuate but later recurving, ± 10 mm long; anthers yellow, ± 5 mm long with short apiculus 0.5 mm long. *Ovary* ellipsoid, ± 4 mm long; style ± 9 mm long, dividing opposite anther bases, branches 1 mm long, expanded apically. *Capsule* and *seeds* unknown. *Flowering time*: December.

*Distribution and biology*: *Tritoniopsis flava* is known from a single population in the Palmiet River Valley (Figure 2). The plants grow in seasonally damp soils along a stream and flower only in the season following a burn. The vegetation at the site regenerates rapidly and within a few seasons the area is covered with a dense growth of woody vegetation.

*History*: this enigmatic species is known from a single collection made in 1999 during a survey of the flora of the Kogelberg Biosphere Reserve. The plants appeared along a small tributary of the Palmiet River following a fire and have not been seen since. The vegetation across the Palmiet River from this site burned in the summer of 2000 but several visits to apparently similar streams opposite the original site failed to rediscover the species.

*Diagnosis and relationships*: *T. flava* is one of a small group of closely allied species that includes *T. caledonensis* (R.C.Foster) G.J.Lewis, *T. unguicularis*, *T. parviflora* and *T. bicolor*. The alliance is characterised by relatively small, fragrant, cream-coloured to yellow flowers with abruptly clawed tepals in which the claws are channelled or involute, and by the short style branches. The species are distinguished on details of flower colour, size and proportions, and by leaf shape and venation. The alliance is restricted to the mountains of the southwestern Cape between the Cederberg and Bredasdorp. *T. flava* is most likely to be confused with *T. parviflora* or *T. bicolor* on account of the size of its flowers but is distinguished from these species by its robust habit, narrowly lanceolate leaves mostly 5–8 mm wide with 2 or 3 main veins, and by the lack of extensive maroon coloration on the lower tepals. It also lacks the papillate mouth of the tube and palate that characterises the flowers of these two species. All three of these species appear to flower only in the season following a summer burn.

***Tritoniopsis toximontana* J.C.Manning & Goldblatt**, sp. nov., plantae 300–650 mm altae usitate eramosae vel 1–2-ramosae, cormo globoso 30–50 mm diam. tunicis fibris dense implexis rubrobrunneis conferto, foliis 4 vel 5 inferioribus 1–2 basalibus siccis ad tempore flore di in pseudopetiolium teretem 100–150 mm longum abrupte infime contractis, lamina linearo-lanceolata 200–300 × 5–10 mm prominente trinervata, foliis caulinis 3 vaginantibus omnino, spica 5–9-flora, bracteis viridibus infime siccis roseis superne, externa 10–12 mm longa acuta, interna 14–16 mm longa acuminata, floribus zygomorphis inodoris pallide roseis tepalibus inferne albis atrorubrisque notatis basibus filamentarum et ore tubi atrorubris coloratis, perianthii tubo 20–21 mm longo, tepalis inaequalibus dorsale 23–25 × 7–9 mm inferioribus tribus 22–25 mm longis infime 5–6 mm connatis, filamentis 13–15 mm longis, antheris 7–8 mm longis apiculis ± 2 mm longis usitate bifurcatis ferentibus, styli ramis 3–4 mm longis ad apicem parum dilatatis.

**TYPE.**—Western Cape, 3118 (Vanrhynsdorp): Gifberg, near top of pass, sheltered sandstone slope in arid fynbos, (–DD), 22 Mar. 2000, Manning 2234 (NBG, holo.; K, PRE, iso.).

Plants 300–650 mm high. *Corm* globose, 30–50 mm diam., tunics of densely matted reddish brown fibres with thick neck to 150 mm long. *Leaves* 4 or 5, the lower 1 or 2 basal, dry at flowering, contracted abruptly into slender, terete pseudopetiole 100–150 mm long, blade linear-lanceolate, 200–300 × 5–10 mm, attenuate, oblique at base, with 3 main veins, abaxial vein diverging first, cauline leaves 3, reddish brown, lanceolate, clasping throughout, lowermost to 60 mm long, upper reduced and bract-like. *Stem* slender, straight or slightly flexuose, usually unbranched, rarely with one or two single-flowered branches; branches filiform and suberect. *Spike* laxly 5–9(–12)-flowered, 300–600 mm long, lateral spikes 1-flowered; bracts green at base but dry and flushed pink in upper half at flowering, soft and more or less membranous, oblong, outer bracts 10–12 mm long, acute, inner bracts 14–16 mm long, acuminate. *Flowers* zygomorphic, unscented, pale pink, three lower tepals each with dark red median streak outlined in white and flanked at base by dark pink streak, upper laterals usually with darker median streak near apices, mouth of tube and bases of filaments flushed dark red; perianth tube straight or slightly curved, very slightly widened to throat, 20–21 mm long; tepals unequal, dorsal slightly ascending and recurved above, others directed forward below and recurved above, dorsal largest, oblanceolate, 23–25 × 7–9 mm, narrowed below, upper laterals 22–25 × 3.5–5.0 mm, lower tepals as long as upper laterals but usually slightly narrower, fused to one another for 5–6 mm. *Filaments* arcuate but later recurving, 13–15 mm long; anthers purple, 7–8 mm long including recurved, usually bifid apiculus ± 2 mm long. *Ovary* ellipsoid, ± 4 mm long; style 35–37 mm long, dividing slightly beyond anther apices, branches ultimately 3–4 mm long, slightly expanded apically. *Capsule* ovoid to ellipsoid, somewhat inflated, 15–23 mm long. *Seeds* tetrahedral, ± 6 × 4 mm, reddish brown, winged on angles and rugose on faces. *Flowering time*: March to early May. Figure 3.

**Distribution and biology:** *Tritoniopsis toximontana* is known only from the Gifberg and Matsikamma Mountains (Figure 2), where it is quite common in arid fynbos on the summit plateau, although apparently absent from the highest reaches of the Matsikamma. It is possible that the species extends northwards along the Bokkeveld Mountains but a search there in March 2000, failed to discover the species. The plants grow tightly wedged among sandstone boulders in sheltered situations, often on cooler slopes. The leaves are dry at flowering time or sometimes those of the next season's growth are emergent.

The pink, long-tubed perianth with dark red throat and tepal markings of *T. toximontana* are typical of plants adapted to pollination by long-proboscid nemestrinid and tabanid flies in South Africa (Goldblatt & Manning 2000b). The floral tube is shorter than is usual among such plants, however, and *T. toximontana* is visited and

pollinated by bees in the genus *Amegilla* (Apidae: Anthophorinae) as well as a moderate-sized nemestrinid fly in the genus *Prosoeca* (unpublished observations). The nemestrinid was also observed visiting the pink flowers of *Brunsvigia striata* in the same area. Both of these plant species appear to belong to an autumn-flowering guild that is pollinated by this as yet unnamed species of long-proboscid fly.

**History:** the species was first collected by Nan Horrocks, an assistant in the Compton Herbarium, in 1965, several years after Lewis' revision of the genus (Lewis 1959). Although Lewis subsequently saw this collection, she identified it as *T. ramosa* var. *unguiculata* (Baker) G.J.Lewis, apparently on the basis of the long perianth tube. *Tritoniopsis toximontana* was collected only twice in the thirty years following Lewis' death in 1967. The most recent collection, by Cape Town environmentalist and botanist Nick Helme, alerted us to the fact that it represented an undescribed species. *Tritoniopsis toximontana* is quite common on the Gifberg plateau and its late flowering habit must account for the fact that it has not been collected more frequently from a locality that is relatively well-visited by botanists.

**Diagnosis and relationships:** the long-tubed pink flowers of *T. toximontana* are superficially similar to those of *T. revoluta* (Burm.f.) Goldblatt and *T. flexuosa* (L.f.) G.J.Lewis but these species are both characterised by large, usually firm floral bracts, 15–35 mm long. The bracts of *T. toximontana* are softer and membranous and only 12–15 mm long. Although the leaves in most species of *Tritoniopsis* are narrowed towards the base of the blade into a flattened pseudopetiole, there are only four in which the pseudopetiole is terete and completely lacking in marginal flanges of blade tissue. This shared character seems to indicate that *T. burchellii* (N.E.Br.) Goldblatt, *T. triticea* (Burm.f.) Goldblatt, *T. flexuosa* and *T. toximontana* comprise a monophyletic group. However, the differences between the species in bract shape and texture, and particularly in the form of the cauline leaves suggests that this relationship, if correct is not a close one. The closely related red-flowered *T. burchellii* and *T. triticea* are unusual in the genus in their aristate cauline leaves and small, woody capsules and cannot be confused with any other species. Among the pink-flowered species with terete leaf bases, *T. toximontana* differs from *T. flexuosa* not only in the bracts but also in the leaf. The leaf blade in *T. flexuosa* is unique in the genus in being oblong and at most 60 mm in length, whereas the blade in *T. toximontana* is narrowly lanceolate-attenuate and 200–300 mm long.

#### *Additional material examined*

**WESTERN CAPE.**—3118 (Vanrhynsdorp): Matsikamma Mountains, Op de Berg 314, just west of Kōelkop Trig Beacon. (–DB), 1 Apr. 1997, Helme 1254 (NBG); Gifberg Mtn top, (–DD), 7 May 1965, Horrocks 205 (NBG); 12.7 km from Zandkraal turnoff at top of Gifberg Pass, (–DD), 30 Mar. 1982, Snijman 595 (NBG).

#### ACKNOWLEDGEMENTS

We are grateful to Nick Helme for bringing two of the new species to our attention, Mark and Ameida Johns for

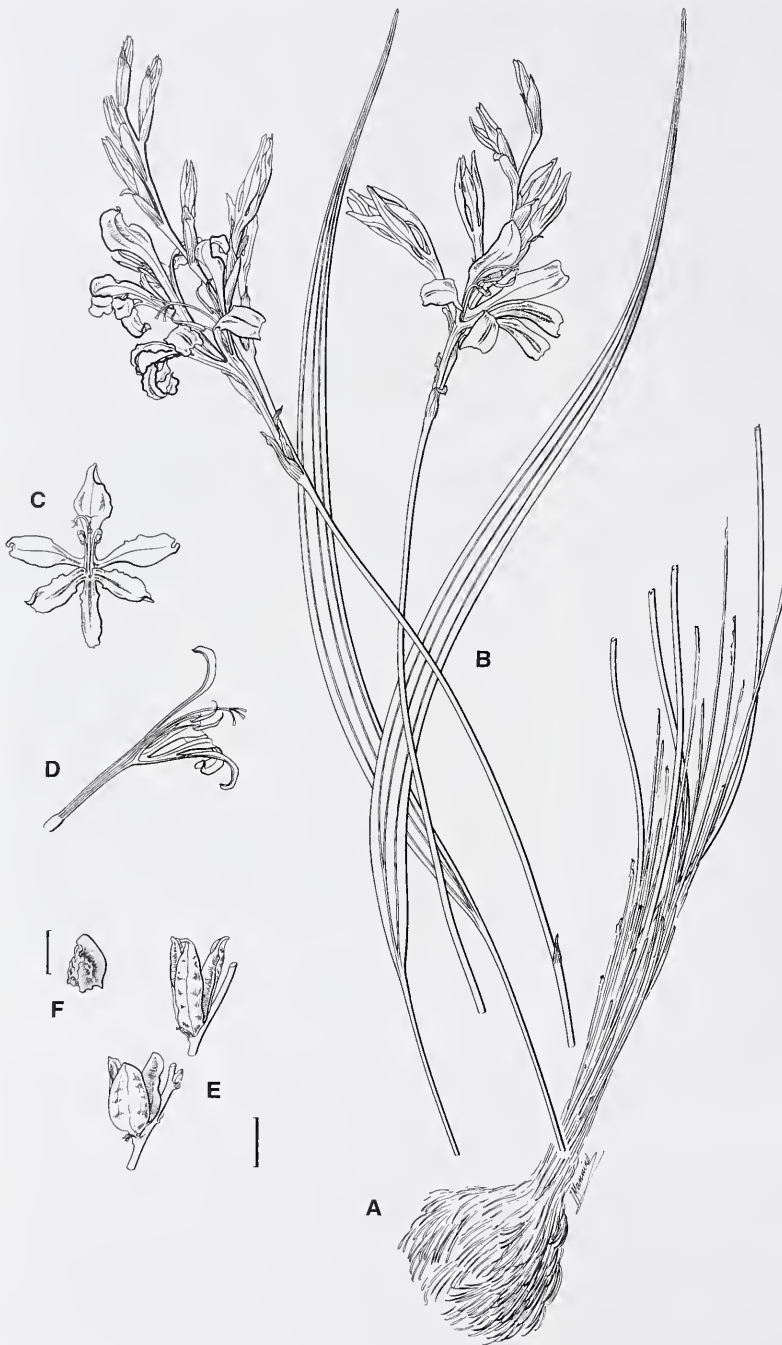


FIGURE 3.—*Tritoniopsis toximontana*. A, corm; B, flowering spikes and leaves. C, D, flower: C, front view; D, half flower. E, capsules; F, seed. Scale bars: A–E, 10 mm; F, 5 mm. Artist: John Manning.

help in the field, and to both the Western Cape Nature Conservation Board and the Northern Cape Nature Conservation Service for collecting permits.

#### REFERENCES

- BOLUS, L. 1929. Plants—new and noteworthy. *South African Gardening & Country Life* 19: 123.
- GOLDBLATT, P. 1990. Status of the southern African *Anapalina* and *Antholyza* (Iridaceae) genera, based solely on characters for

- bird pollination, and a new species of *Tritoniopsis*. *South African Journal of Botany* 56: 577–582.
- GOLDBLATT, P. & MANNING, J.C. 2000a. Cape plants. A conspectus of the Cape Flora of South Africa. *Strelitzia* 9.
- GOLDBLATT, P. & MANNING, J.C. 2000b. The long-proboscid fly pollination system in southern Africa. *Annals of the Missouri Botanical Garden* 87: 146–170.
- GOLDBLATT, P., BERNHARDT, P. & MANNING, J.C. 2000. Adaptive radiation of pollination mechanisms in the African genus *Ixia* (Iridaceae: Crocoideae). *Annals of the Missouri Botanical Garden* 89: 564–577.
- LEWIS, G.J. 1959. South African Iridaceae. The genus *Tritoniopsis*. *Journal of South African Botany* 25: 319–355.



- LEWIS, G.J. 1960. South African Iridaceae. The genus *Anapalina*. *Journal of South African Botany* 26: 51–72.
- MANNING, J. & GOLDBLATT, P. In press. The pollination of *Tritoniopsis parviflora* (Iridaceae) by the oil-collecting bee *Rediviva gigas* (Hymenoptera: Melittidae): the first record of oil-secretion in African Iridaceae. *South African Journal of Botany*.
- PHILLIPS, E.P. 1951. The genera of South African flowering plants, edn 2. *Memoirs of the Botanical Survey of South Africa* No. 25.
- WHITEHEAD, V.B. & STEINER, K.E. 1993. A new *Rediviva* bee (Hymenoptera: Apoidea: Melittidae) that collects oil from orchids. *African Entomology* 1: 159–166.



## Studies in the liverwort family Aneuraceae (Metzgeriales) from southern Africa. 2. The genus *Riccardia* and its type species, *R. multifida*, with confirmation of its presence in the region

S.M. PEROLD\*

**Keywords:** Aneuraceae, *Riccardia* Gray, Riccardiaceae, *R. multifida* (L.) Gray, *R. saccatiflora* (Steph.) S.W.Arnell, southern Africa, type species

### ABSTRACT

A generic description of *Riccardia* Gray is presented, as well as confirmation of the local presence of its type species, *R. multifida* (L.) Gray, which is described and illustrated. Arnell (1952; 1963) incorrectly identified his collections of this species as *R. saccatiflora* (Steph.) S.W.Arnell: some notes on it are added.

### INTRODUCTION

In my previous account of the Aneuraceae (Perold 2001), I distinguished between the two locally occurring genera, *Aneura* Dumort. and *Riccardia* Gray, and briefly traced the taxonomic history of the family in our region, as well as that of the areas to the north. Short descriptions of the family and the genus *Aneura* were presented, as well as a detailed description and an illustration of *A. pinguis* (L.) Dumort.

In the present publication a short account of the genus *Riccardia* is given, as well as a detailed description and illustration of *R. multifida* (L.) Gray. Lehmann (1829) had previously reported the presence of this species and two of its varieties on Table Mountain, and Gottsche *et al.* (1844–1847: 788) mentioned its occurrence at the Cape. Arnell (1952, 1963), however, did not allude to it at all, having misidentified his collections of it as *R. saccatiflora*. Reports of its local occurrence by Müller (1951–1958) and by Smith (1990), were probably based on Lehmann's work and the brief reference to it by Gottsche *et al.*

***Riccardia* Gray**, A natural arrangement of British plants: 679, 683 (1821) as '*Riccardius*', correction by Trevis.: 785 (1874) to '*Riccardia*'; Hewson: 75 (1970); Brown & Braggins: 25 (1989); Furuki: 323 (1991); R.M.Schust.: 579 (1992); Paton: 540 (1999); Bednarek-Ochyra *et al.*: 178 (2000). Lectotype: *Riccardia multifida* (L.) Gray (*Jungermannia multifida* L.).

Synonyms are given in Hewson (1970); Brown & Braggins (1989) and R.M. Schust. (1992).

Thalli prostrate to ascending, pale to dark green, cell walls sometimes turning brown, rather delicate, somewhat fleshy or not, short or long, length up to 40 mm, sometimes more, narrow, 0.5–2.0 mm wide, lingulate to linear, apices truncate, rounded or emarginate, margins obtuse to acute. Branching lateral, pinnate to quadripinnate, rarely multipinnate, stolons sometimes present. Dorsal epidermal cells

thin-walled, smaller than internal cells. Oil bodies 1–3 in each epidermal cell, sometimes more, rarely absent, ovoid, spherical or ellipsoid, 12.5–22.5 × 10.0–12.5 µm, also present, although larger, in internal cells, composed of numerous fine globules, opaque, black or brown. Cross section of branches plano-convex, biconvex or concavo-convex, rarely circular, 3–9 cells thick medianly, at margins acute to winged or not. Mucilage papillae ventral, in 2 acropetal rows, one on each side of midline and at branch apices. Rhizoids usually present, numerous on ventral surface, unicellular. Asexual reproduction by 2-celled gemmae, endogenously produced by epidermal cells, frequently present.

Monoicous, dioicous or synoicous. Male branches lateral on main axis or on pinnae/primary branches, linear to ligulate, sometimes in sympodial clusters, antheridia in 2 regular rows, in chambers usually separated by unistratose cell walls, dorso-lateral wing up to 8 cells wide. Female branches short, lateral on main axis or on pinnae, archegonia in 2 rows, protected by fringe of finger-like or lamellate paraphyses. Shoot-calyptra large and fleshy, up to ± 5 mm long, 0.7–1.1 mm wide, wall 5 or more cell layers thick, surface smooth to rough, apical cells, i.e. corona, poorly to well developed. Seta in cross section with 4 inner and 12 outer cell rows (4 cells diam.). Capsule ellipsoidal, 4-valved, wall bistratose, cells of external layer with thickenings on adaxial radial and inner tangential walls, cells of inner layer mostly without thickenings, although the adaxial radial wall is sometimes slightly thickened. Spores spherical, finely scabrate, small, 9–15 µm diam. Elaters 120–350 µm long, 8–10 µm wide, unispiral.

The genus *Riccardia*, was named in honour of Vincenzo Riccardi, a resident of Florence during the early years of the 18th century, and a donor to Micheli's (1729) *Nova plantarum genera*.

***Riccardia multifida* (L.) Gray**, A natural arrangement of British plants 1: 684 (1821); A.Evans: 22, 23 (1937); Müll.Frib.: 499 (1954); R.M.Schust.: 316 (1987); R.M.Schust.: 618 (1992); Paton: 541 (1999). Type: Europe.

*Aneura multifida* Dumort.: 115 (1822); Müll.Frib.: 336 (1908); Macvicar: 54 (1926).

\* National Botanical Institute, Private Bag X101, Pretoria 0001. MS. received: 2001-07-02.



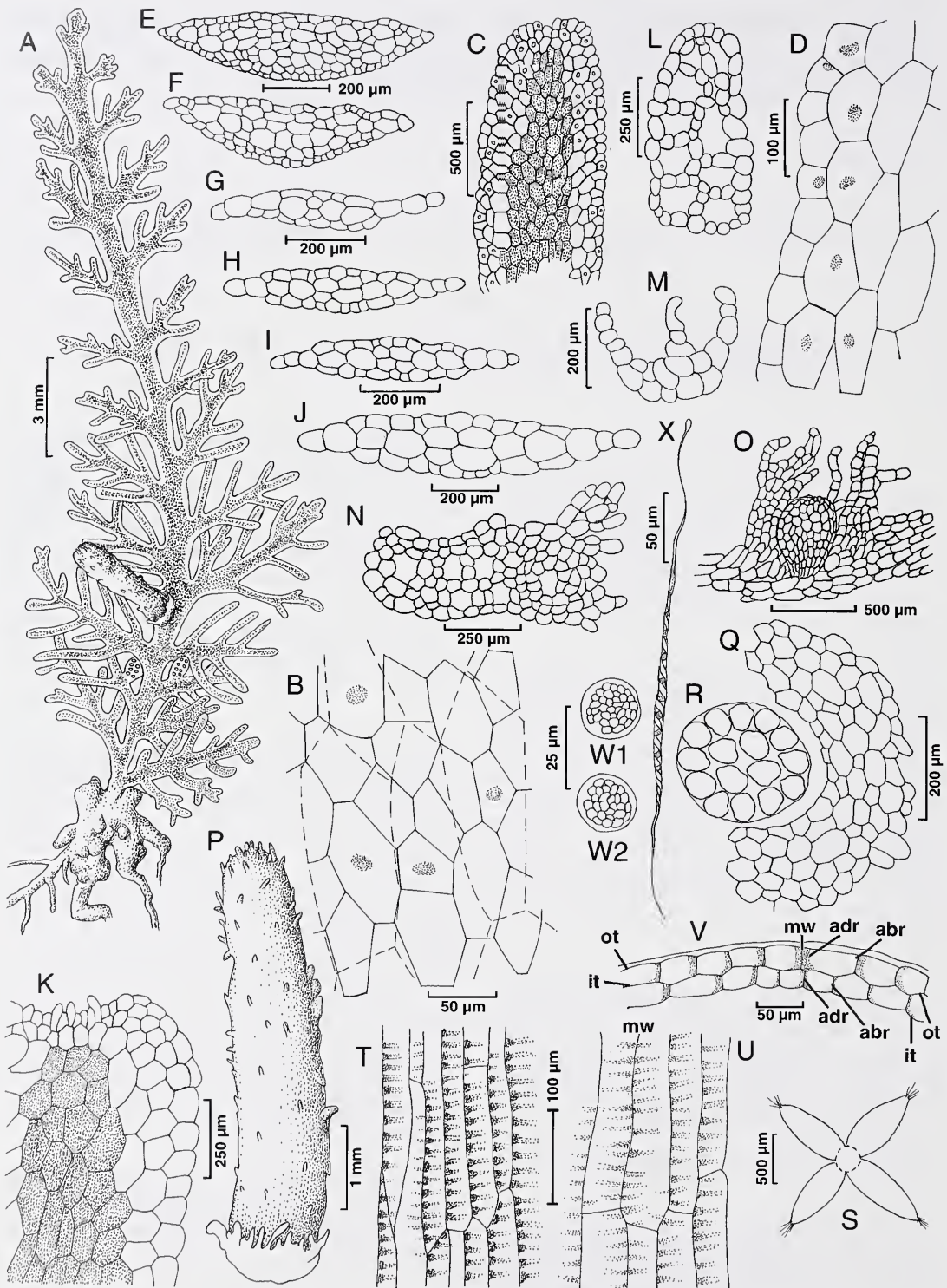


FIGURE 1.—*Riccardia multifida*. A, thallus with axis and lateral branches, 2- or 3-pinnate; B, median dorsal epidermal cells (solid lines) of ultimate segment of axis without oil bodies, but present in large subdorsal cells (stippled lines); C, ultimate pinnule, some marginal cells with oil bodies, medianly opaque; D, margin of ultimate pinnule, oil bodies mostly absent in outer, but present in inner cell rows; E, F, c/s axis at ± middle of ultimate segment; G–J, c/s ultimate pinnules; K, ventral surface of part of pinnule, with mucilage papillae at apex. L, M, antheridial branch: L, from above; M, c/s. N, synoicus branch; O, gynoeical branch with paraphyses; P, Q, calyptra: Q, c/s wall. R, c/s seta; S, capsule with 4 dehiscent valves. T–V, valve: T, cells of epidermal layer in external longitudinal view; U, cells of inner layer in internal longitudinal view; V, c/s part of bistratose wall (thickenings partly after Evans 1937). Wall: mw, median; ot, outer tangential; it, inner tangential; adr, adaxial radial; abr, abaxial radial. W1, W2, spores; X, elater. *Perold & Koekemoer* 4449–4452: A, C, F–M, P, W1, W2, X, 4449; B, 4452; D, R, 4450; E, N, O, Q, S–V, 4451.

*Jungermannia multifida* L.: 1136 (1753).

For a complete list of synonyms, Schuster (1992) may be consulted.

Thalli prostrate to suberect, in loosely or densely overlying and intricately intertwining mats, rather light green, sometimes at maturity cell walls brown, opaque, with narrow, translucent margins (Figure 1A); when dry, dark green; medium-sized to large, flat and flabellate above. *Main axis* dorsally plane to convex or slightly concave, often retaining its dominance, up to 27 mm long, 0.82–1.05 mm wide, apically rounded or slightly emarginate, eventually narrowing somewhat toward base, margins acute and unistratose for a width of 1 or 2 cells. *Primary branches* lateral, opposite or subopposite, 0.8–1.4 mm between successive ones, obliquely spreading, often overlapping, regularly pinnate with pinnae well developed, linear, distally with 2 or 3 paired pinnules, proximally with 4 or sometimes even 5 paired pinnules, older, primary branches/pinnules up to 4.7 mm long, 590–650  $\mu\text{m}$  wide, secondary branches/pinnules 0.75–1.6 mm long, 475–530  $\mu\text{m}$  wide; from base of main axis or from apices of secondary branches, flagelliform branches sometimes produced. *Dorsal epidermal cells* in median part of apical segment of main axis (Figure 1B), from above 5–7-sided, thin-walled, 62.5–105.0  $\times$  25.0–37.5 (–55.0)  $\mu\text{m}$ , subdorsal cells larger, 4–7-sided, 155.0–262.5  $\times$  62.5–87.5  $\mu\text{m}$ , subventral cells 170.0–237.5  $\times$  60–85  $\mu\text{m}$ , ventral epidermal cells 75–100  $\times$  30.0–47.5  $\mu\text{m}$ . *Oil bodies* rare or absent in dorsal and ventral epidermal cells, absent in up to 70% of marginal cells, present in internal cells, 1 or occasionally 2 per cell, 15–25  $\times$  7.5–12.5  $\mu\text{m}$ , subspherical, ellipsoidal or ovoid, with rounded ends, light brown, opaque, composed of numerous small globules. *Margins* of ultimate pinnules crenulate (Figures 1C, D; 2A), outer cells smaller than intramarginal ones, from above 35–55  $\times$  35.0–47.5  $\mu\text{m}$ ,  $\pm$  subquadrate, with free walls bulging, intramarginal cells often obliquely orientated, polygonal, 72.5–100.0  $\times$  47.5–52.5  $\mu\text{m}$ , generally with 1 oil body each. *Cross section* of main axis at middle of ultimate segment (Figure 1E, F) plano-convex, or weakly concavo-convex, sometimes biconvex, 180  $\mu\text{m}$  or 6(7) cell rows thick medianly, gradually tapering to unistratose margins, 1 or 2 cells wide, dorsal cells  $\pm$  27.5  $\mu\text{m}$  thick, internal cells 37.5–50.0  $\mu\text{m}$  thick; cross section of ultimate pinnule of primary branch (Figure 1G–J) 100  $\mu\text{m}$  or 3 or 4 cells thick medianly, pellucid, unistratose margins 2 or 3 cells wide. *Mucilage papillae* ventral (Figure 1K), clustered at slightly emarginate apex of branch and in 2 spaced, acropetal rows, one on either side of midline, 300–360  $\mu\text{m}$  between successive ones, reddish, club-shaped, 2-celled, above 45.0–62.5  $\times$  25.0–32.5  $\mu\text{m}$ , narrowing to inconspicuous basal cell, non-persistent. *Rhizoids* ventral on axes, sometimes also on pinnae, hyaline, 7.5–15.0  $\mu\text{m}$  wide. *Asexual reproduction* by gemmae seemingly absent.

Heteroicous, with male, female and rarely synoicous branches. *Antheridial branches* lateral, near base of primary pinnae, on one or both sides, occasionally at tips of secondary pinnules, oblong-linear (Figure 1L),  $\pm$  700  $\mu\text{m}$  long, 350  $\mu\text{m}$  wide, in cross section 240  $\mu\text{m}$  high (Figure 1M), margins crenulate, with single, erect layer of swollen cells, 62.5–77.5  $\times$  45–50  $\mu\text{m}$ , bearing 5 or more pairs of antheridia, separated by unistratose cell layer; very rarely synoicous (Figure 1N), basally with paired antheridia and apically with a few archegonia and

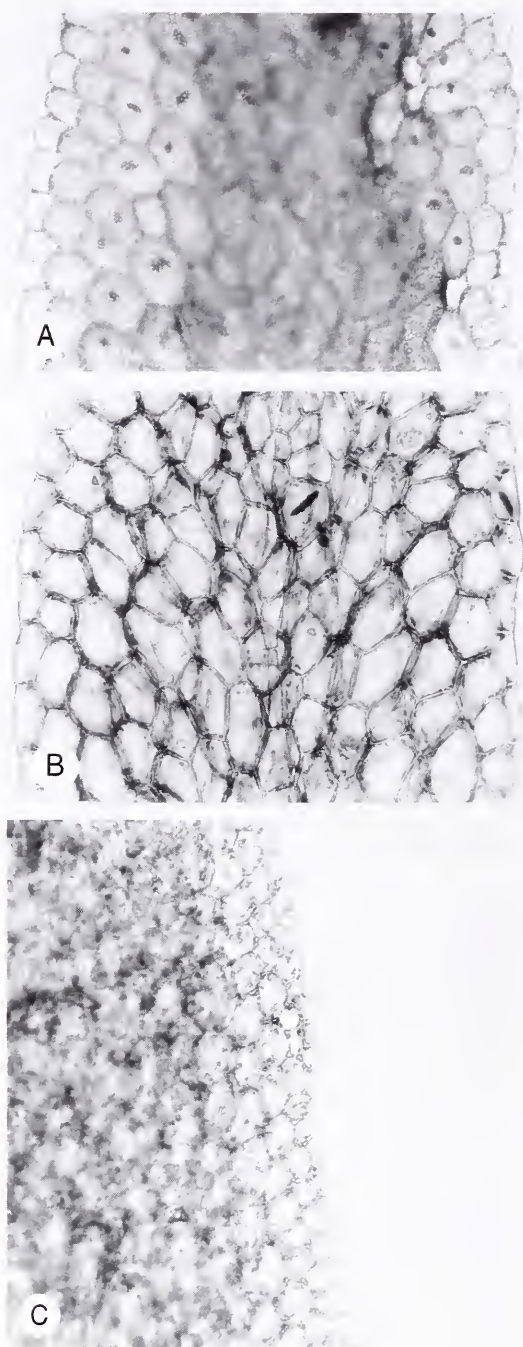


FIGURE 2.—*Riccardia multifida*: A, pinnule (living), with outwardly bulging marginal cells along both margins; B, fully rehydrated pinnule, (collected 1951), with marginal cells not bulging outwardly. *R. saccatiflora*: C, fully rehydrated pinnule (collected late 1800s), with much smaller marginal cells not bulging outwardly, only one margin shown. A, Perold & Koekemoer 4449; B, S.W. Arnell 1952 (S); C, Rodríguez G10699 (G). A–C,  $\times$  114.

short, lacinate cilia at tip. *Gynoeical branches* short, arising opposite base of primary branch on main axis, or toward base of main axis, sometimes toward middle of primary branch, between pinnae of 1st and 2nd



orders, or between pinnae of 2nd and 3rd orders; paraphyses between and surrounding archegonia (Figure 1O), up to 437.5 µm long, composed of single strands of 9 or more cells, joined end to end; sometimes up to 3 female branches in a sympodial cluster. *Calyptra* (Figure 1P) clavate, 3.2–5.3 × 0.7–1.1 mm, cross section of wall up to 225 µm or 4–6 cells thick (Figure 1Q), outermost row with scattered, thick-walled papillae, 65–90 × 25–65 µm, extending upwards to apex, where they are grouped together, forming a corona. *Seta* ± 12 mm long, ± 280 µm wide, with 4 inner and 12 outer cell rows, i.e. 4 cells diam. (Figure 1R). *Capsule* ± cylindrical, 1200–1450 µm long, with 4 dehiscent valves (Figure 1S). 320–375 µm or 12–15 cells wide, bistratose; cells of epidermal layer in external longitudinal view (Figure 1T), 100.0–142.5 × 25–35 µm, with straight or oblique end walls, and strong nodular thickenings; in cross section (Figure 1V) cells ± rectangular in shape, thickenings on adaxial radial (adr) and inner tangential (it) walls sometimes extending slightly to outer tangential (ot) walls, mostly bands on one side of median wall (mw) alternating with those on the other side, i.e. forming a mirror image; inner cells in internal longitudinal view (Figure 1U), 112.5–132.5 × 25–35 µm, never with nodular thickenings; in cross section (Figure 1V) cells faintly thickened on adaxial radial (adr) and sometimes extending slightly on inner tangential (it) walls. *Spores* (Figure 1W1, W2) 15–20 µm diam., translucent, finely scabrate, pinkish, with inner, irregularly shaped, green areas. *Elaters* (Figure 1X) 245–390 µm long, 10–14 µm wide, with single spiral band, tapering to unspiralled tips. *Elatrophores* at valve apices (Figure 1S), in persistent tufts. *Chromosome no.*: n = 20.

*Riccardia multifida* is a widespread species or species complex which Schuster (1992) says, extends from the northern Spruce–Fir zone southwards. According to Schuster, two subspecies occur in North America, i.e. *R. multifida* subsp. *multifida*, with a more northerly range along the western states, and *R. multifida* subsp. *synoica* with a more southerly range along the eastern states. Apart from occupying a different geographical range, the latter subspecies is also distinguished from the former autoicous one, by most of its inflorescences being bisexual and by its preference for growing on rotting wood. *R. multifida* subsp. *multifida* is further known from Newfoundland, Greenland, Iceland, British Isles, Macaronesia, Europe, North Africa, Madagascar, Sikkim-Himalaya, West Java (Meijer 1959) and China (Yunnan). Another subspecies, *R. multifida* subsp. *decrescens*, is reported from Japan by Furuki (1991). Reports of *R. multifida* from the Falklands have been excluded according to Engel (1990). As far as is known, it also does not occur in Australia, New Zealand or in South America, although there is an unconfirmed report from the Andes (Gottsche 1864). Müller (1951–1958) remarked that, 'Die Angaben von der südlichen Hemisphäre gehören aber vielleicht nicht zu *R. multifida*.' Wigginton & Grolle (1996) also do not include it in their *Catalogue of the Hepaticae and Anthocerotae of sub-Saharan Africa*. Jones (1956), however, observed that a specimen collected from the 'Foresta di Tusu, Mt Kenya' and described by Gola (1914), appeared to him to be identical with *R. multifida*. Schuster (1992), on the other hand, thinks that *R. multifida* may be the only *Riccardia*

species with a reasonably certain bipolar range, as a collection from Campbell Island, south of New Zealand, differs only slightly from holarctic plants, although he concedes that it needs more study.

Schuster (1992), with his extensive knowledge and customary astuteness, expressed the opinion that, of the species that Arnell (1952, 1963) reported from South Africa, *R. saccatiflora* 'seems virtually inseparable from *R. multifida*'. After thorough examination of Arnell's collections, I share this view, although it must be admitted that Arnell's drawings do not show the regular bi- and tripinnate branching generally exhibited by *R. multifida*. However, the narrow translucent margins of the ultimate pinnules of his specimens are conspicuous (Figure 2B), and may have misled him into thinking he was dealing with *R. saccatiflora*. Otherwise, it is surprising that Arnell made this mistake, as he should have been familiar with *R. multifida*, having treated it for the *Illustrated moss flora of Fennoscandia* (Arnell 1956).

Study of the type and five other Rodriguez collections of *R. saccatiflora* from Réunion (Bourbon), as well as Stephani's *Icones* (1985) nos. 000229 and 000230, showed that the unistratose marginal cells of the ultimate pinnules form a distinct wing, but are small (Figure 2C); they measure 27.5–32.5(–45.0) × 10–20(–35) µm, whereas the intramarginal cells are only slightly larger, 37.5–42.5 × 25–30 µm. In cross section the ultimate pinnules are 4 or 5 cell layers or 100 µm thick medianly and the main axes 8 cell rows or 300 µm thick. Stephani (1890) referred to the marginal cells as 'multo-minores'.

Arnell (1963) reported the oil bodies of his '*R. saccatiflora*' collections to be 'dark, large, composed of very small droplets, one per cell'. In their examination of *R. saccatiflora* specimens, Meenks & Pócs (1985) found that their oil body data agreed well with Arnell's observations, but added that the oil bodies seem 'rather persistent, since they still occur in some older herbarium collections'. This is not the case in *R. multifida*, where the oil bodies are not persistent. Meenks & Pócs (1985) only cite the literature records from South Africa given by Arnell (1963: 92). Their reports of *R. saccatiflora* from East Africa are, however, accepted for the time being.

Paton (1999) states that, in British *R. multifida*, the occasional synoicous inflorescence occurs on the same thallus as unisexual and paroicous inflorescences, but that such populations are not referable to the American subspecies *synoica* R.M.Schust., in which nearly all the inflorescences are bisexual. The same criteria apply to the South African plants, where synoicous inflorescences are very rare.

The new Perold & Koekemoer collections of *R. multifida* are from Diepwalle Forest Station, near Knysna, in the southeastern part of Western Cape (Figure 3). This is the same vicinity as Gouna Forest, Bracken Hill, Buffels Nek and Garden of Eden, from where Arnell (1952) recorded several of his so-called *R. saccatiflora* gatherings, which have now been transferred to *R. multifida*.

*R. multifida* specimens are distinguished by the following characters: 1, the thalli are markedly feathery, with rather crowded and generally very regular, pinnate



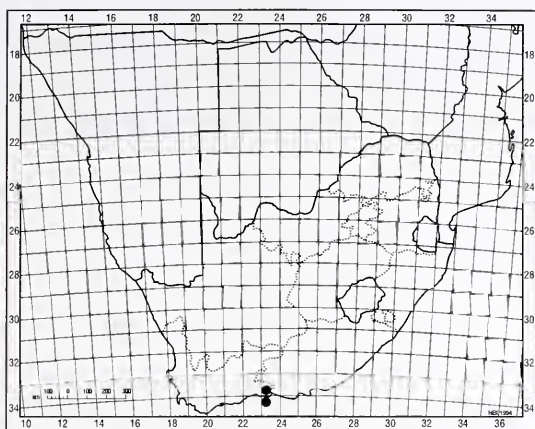


FIGURE 3.—Distribution of *R. multifida* in southern Africa.

branching; 2, the ultimate and lateral pinnules are thin, linear and parallel-sided, with the outer 3 cell rows unistratose and translucent on either side of the thicker, opaque, median region; 3, the ultimate pinnules have crenulate distal margins, with the marginal cells bulging externally and smaller than the intramarginal cells; 4, the oil bodies are mostly absent from the marginal and epidermal cells of the median region, but present in the internal cells; 5, the epidermal cells of the median part are generally narrower than in allied species, i.e. 25.0–37.5(–55.0)  $\mu\text{m}$  wide; 6, the plants are rarely synoicous.

#### ECOLOGY

*Riccardia multifida* plants grow on soil, twigs, dead leaves or decaying wood in forested areas at streambanks or seepages, i.e. in constantly wet or damp sites in  $\pm$  diffused light.

#### ACKNOWLEDGEMENTS

The curators of BOL, G and S are thanked for the loan of specimens. I also express my sincere gratitude to Ms M. Koekemoer, curator of PRE, for all her help with fieldwork, and to the referees for their helpful suggestions and advice. The artist, Ms G. Condy, the photographer, Mrs A. Romanowski and the typist, Ms D. Maree are thanked for their valued contributions.

#### REFERENCES

- ARNELL, S.W. 1952. Hepaticae collected in South and West Africa (1951). New and little-known species. *Botaniska Notiser* 105: 307–315.
- ARNELL, S.W. 1956. *Illustrated moss flora of Fennoscandia*. 1. Hepaticae. Gleerup, Lund.
- ARNELL, S.W. 1963. *Hepaticae of South Africa*. Swedish Natural Science Council, Stockholm.
- BEDNAREK-UCHYRA, H., VÁNA, J., UCHYRA, R. & LEWIS SMITH, R.I. 2000. *The liverwort flora of Antarctica*. Polish Academy of Sciences, Institute of Botany, Cracow.
- BROWN, E.A. & BRAGGINS, J.E. 1989. A revision of the genus *Riccardia* S.F.Gray in New Zealand with notes on the genus *Aneura* Dum. *Journal of the Hattori Botanical Laboratory* 66: 1–132.
- DUMORTIER, B.C. 1822. *Commentationes Botanicae*. 1–117. Tournay.
- ENGEL, J.J. 1990. Falkland Islands (Islas Malvinas) Hepaticae and Anthocerotophyta: a taxonomic and phytogeographic study. *Fieldiana* 25: 1029.
- EVANS, A.W. 1937. The structure of the capsule wall in certain species of *Riccardia*. *Annales Bryologici* 10: 20–35.
- FURUKI, T. 1991. A taxonomical revision of the Aneuraceae (Hepaticae) of Japan. *Journal of the Hattori Botanical Laboratory* 70: 293–397.
- GOLA, G. 1914. Le epatiche della regione del Kenia. *Memorie della R. Accademia delle Scienze di Torino*, ser. 2. 65: 1–11.
- GOTTSCHE, C.M. 1864. Hepaticae. In Triana & Planchon, *Prodromus florae nova granatensis. Annales des sciences naturelles, bot.* sér. 5, 1: 95–198.
- GOTTSCHE, C.M., LINDENBERG, J.B.G. & NEES AB ESENBECK, C.G. 1844–1847. *Synopsis hepaticarum*. Meissner, Hamburg. Reprinted 1967, Cramer, Lehre.
- GRAY, S.F. 1821. *A natural arrangement of British plants* 1: 1–824. London.
- HEWSON, H.J. 1970. The family Aneuraceae in Australia and New Guinea: II. The genus *Riccardia*. *Proceedings of the Linnean Society of New South Wales* 95: 60–121.
- JONES, E.W. 1956. African Hepatics XI. The genus *Riccardia* in tropical Africa. *Transactions of the British Bryological Society* 3: 74–84.
- LEHMANN, J.G.C. 1829. Hepaticarum capensium a C.F. Ecklon collectarum brevem rescensionem. *Linnaea* 4: 357–371.
- LINNAEUS, C. 1753. *Species plantarum*. Salvius, Stockholm.
- MACVICAR, S.M. 1926. *The student's handbook of British hepatics*, edn 2. Sumfield, Eastbourne. Reprinted 1964.
- MEENKS, J.L.D. & PÓCS, T. 1985. East African Bryophytes IX. Aneuraceae. *Abstracta Botanica* 9: 79–98.
- MEIJER, W. 1959. Notes on species of *Riccardia* from their type localities in western Java. *Journal of the Hattori Botanical Laboratory* 21: 73, 74.
- MICHEL, P.A. 1729. *Nova plantarum genera*. Paperini, Florence.
- MÜLLER, K. (Müll.Frib.) 1905–1916. *Die Lebermoose Deutschlands, Oesterreichs und der Schweiz. Dr L. Rabenhorst's Kryptogamen-Flora* 2, edn 6, part 1: 1–870. Geest & Portig, Leipzig.
- MÜLLER, K. (Müll.Frib.) 1951–1958. *Die Lebermoose Europas. Dr L. Rabenhorst's Kryptogamen-Flora* 6, edn 3: 492–505. Geest & Portig, Leipzig.
- PATON, J.A. 1999. *The liverwort flora of the British Isles*. Harley Books, Colchester.
- PEROLD, S.M. 2001. Studies in the liverwort family Aneuraceae (Metzgeriales) from southern Africa. 1. The genus *Aneura* and its local representative. *Bothalia* 31: 167–173.
- SCHUSTER, R.M. 1987. Studies on Metzgeriales: 1. North American Aneuraceae. *Journal of the Hattori Botanical Laboratory* 62: 299–329.
- SCHUSTER, R.M. 1992. *The Hepaticae and Anthocerotae of North America* 5: 1–854. Field Museum of Natural History, Chicago.
- SMITH, A.J.E. 1990. *The liverworts of Britain and Ireland*. Cambridge University Press, Cambridge.
- STEPHANI, F. 1890. Hepaticae africanae novae in insulis Bourbon, Maurice et Madagascar lectae. *Botanical Gazette* (Crawfordsville) 15: 281–292.
- STEPHANI, F. 1985. *Icones hepaticarum*, microfiche. Inter Documentation Company, Leiden.
- TREVISAN DE SAINT-LÉON, V.B.A. 1874. Nuovo censo delle epatiche italiane. *Rendiconti Reale Istituto Lombardo di Scienze e Lettere*, Sér. 2, 7: 776–786.
- WIGGINTON, M.J. & GROLLE, R., Supplemented by GYARMATI, A. 1996. Catalogue of the Hepaticae and Anthocerotae of sub-Saharan Africa. *Bryophytorum Bibliotheca* 50. Cramer, Berlin, Stuttgart.

#### SPECIMENS EXAMINED

##### *Riccardia multifida*

Arnell 1515 Buffels Nek, 1592\*, 1731 Gouna For. (BOL), 1839 Diepwalle For. Res. (BOL), 1843\*• (BOL, PRE), 1844\*, 1845 (BOL), 1918 (PRE), 1929 (BOL), 1952 (S), 1974 Bracken Hill For. (BOL), 2079, 2133 Garden of Eden (BOL).

Perold & Koekemoer 4449, 4450, 4451, 4452, Diepwalle Forest Reserve, Knysna District, Western Cape.

##### *Riccardia saccatiflora*

Rodriguez G010697 (G) (type specimen), G010698 (G), G010699 (G), G010700 (G), G010702 (G), G010703 (G) Bourbon (Réunion).

• on decaying wood.

\* 1/2 mile south of Diepwalle Forest Reserve.



# Notes on African plants

VARIOUS AUTHORS

## IRIDACEAE

### TWO NEW RENOSTERVELD SPECIES OF CROCOIDEAE FROM SOUTH AFRICA

#### INTRODUCTION

Southern Africa and the Cape Floral Region in particular is a major centre of diversity for Iridaceae. Approximately 70% of the species of Iridaceae recorded from southern Africa occur in the Cape Region and most are endemic to it (Goldblatt 1991; Goldblatt & Manning 2000). The family is especially well represented in the west and southwest of the region, which has a true summer-dry climate (Manning *et al.* in press). Local endemism is a common feature among the species in the region. Iridaceae display a high degree of substrate fidelity (Goldblatt & Manning 1996) and edaphic and topographic diversity appear to have played a significant role in speciation in the subcontinent (Goldblatt & Manning 1998). Although the great majority of species recorded from the Cape Floral Region are typically restricted to fynbos vegetation, the vegetation type known as renosterveld historically dominated much of the Cape lowlands. This fine-leaved shrubland occurs on nutrient-intermediate, fine-grained clays derived from shales of the Malmesbury and Bokkeveld Formations and is particularly rich in geophytic species. Now largely transformed by agriculture (Low & Rebelo 1996), renosterveld was commonly found along the coastal forelands as well as in inland drainage basins that are often isolated from one another. The drainage basin of the Breede River, which forms the region known as the Worcester Karoo, is rich in local endemics. Among these are *Ixia collina*, known only from near Aan de Doorns, southeast of Worcester, *I. vanzijliae*, distributed between Worcester and Roberston, and *Sparaxis maculosa*, restricted to the valley of the Hoeks River, a minor tributary of the Breede River, near Villiersdorp in the southwestern corner of the Worcester Karoo. Two additional local endemics restricted to the renosterveld in this area have since been discovered and are described here. It is becoming evident that the Worcester Karoo, known locally as the *Bosjesveld* at least since 1815 when the explorer William Burchell recorded the name (Burchell 1822), is a distinct enclave of endemism for Iridaceae and especially the genus *Ixia*. Fortunately extensive stretches of indigenous renosterbos shrubland still remain undisturbed in this area although it is slowly being removed to establish orchards and vineyards.

***Freesia fucata* J.C.Manning & Goldblatt, sp. nov.**

Plantae 150–300 mm altae, cormo conico 15–20 mm diam. tunicis pallide reticulatis, foliis 5–6 inclinatis vel suberectis linearibus 80–250 × 4–5 mm, caule usitate ramoso minute papillato, spica inclinata 4–9-florum, floribus (30–)35–47 mm longis fragrantibus albis

externe atropurpureis suffusis tepalis inferioribus aurantiacis notatis, tubo perianthii 20–30 mm longo infime filiforme 6–7 mm longo, tepalis inaequalibus, dorsale grandiore suberecto ovato 11–18 × 8–11 mm, inferioribus recurvatis, filamentis 13–15 mm longis, antheris 7–8 mm longis, stylo diviso prope apicem antherarum.

TYPE.—Western Cape, 3319, Villiersdorp Dist., 5.5 km along Doornrivier Road off Villiersdorp-Worcester Road, Farm Die Hoek, (–CD), 10-07-2000, Manning 2271 (NBG, holo.; MO, PRE, iso.).

Plants 150–300 mm high. *Corm* conic, 15–20 mm diam., tunics pale, medium-textured, reticulate, accumulating with age and forming neck around base of stem. *Leaves* 5 or 6, inclined to suberect, linear, tapering above, acute, 80–250 mm long, usually about as long as stem, 4–5 mm wide, cataphylls flushed deep purple. *Stem* minutely papillate, flexed outward above uppermost sheath and then suberect, usually with one or two branches. *Spike* lightly decumbent, 4–9-flowered; bracts soft, herbaceous, green with hyaline margins, tricuspidate, 6–10(–13) mm long; inner bracts slightly shorter, forked. *Flowers* (30–)35–47 mm long, strongly violet-scented, white flushed dull purple on reverse of tepals, base of lower tepals yellow-orange with dark midline; perianth tube 20–30 mm long with basal narrow part 6–7 mm long, widening rather abruptly into wider, flared upper portion; tepals unequal, the dorsal largest, suberect, ovate, 11–18 × 8–11 mm, upper laterals slightly narrower, oblong, lower tepals recurved, lower laterals narrowly ovate, 10–14 × 6–8 mm, lower median oblong, 10–16 × 5–6 mm. *Filaments* arcuate, inserted at base of widened upper portion, included, 13–15 mm long; anthers 7–8 mm long. *Style* dividing at or slightly beyond anther apices, branches deeply forked. *Capsule* oblong, three-lobed, (6–)9–12 × (6–)7–10 mm. *Seeds* globose with inflated chalaza and raphe, rugose, glossy reddish brown, 2.5–3.0 mm diam. *Flowering time*: July. Figure 1.

*Distribution and biology*: the species is known from several populations in the valley of the Hoeks River, in the southwestern corner of the Worcester Karoo, south of Villiersdorp (Figure 2). It occurs on clay soils derived from shales of the Bokkeveld series in open shrubland dominated by the renosterbos, *Elytropappus rhinocerotis*.

*History*: first collected at the type locality in 1975 by the Worcester dentist, I.B. Walters, who had a keen interest in the local flora and collected extensively in the Worcester Valley, this highly fragrant species is known only from this small area.





FIGURE 1.—*Freesia fucata*. A, whole plant; B, flowering spike; C, D, flower: C, front view; D, half flower. E, outer bract (left) and inner bract (right); F, capsules; G, seed. Scale bar: A–F, 10 mm; G, 1.5 mm. Artist: John Manning.

**Diagnosis and relationships:** *F. fucata* has the minutely papillate-puberulous stem, green bracts and narrowly ovate lower tepals characteristic of section *Viridibractea* (Goldblatt 1982). Within the section it is somewhat intermediate between *F. alba* (G.L.Mey.) Gumbleton and *F. caryophyllacea* (Burm.f.) N.E.Br. It has the narrow, erect leaves of the former and the bilabiate, white flowers flushed with purple of the latter. *F. fucata* is, however, unique in the genus in its distinctly tricuspidate outer bracts. *F. alba*, which is characterized by its almost actinomorphic perianth, is essentially a species of the southern Cape coastal forelands, occurring along forest margins or in open scrub in stony, sandstone-derived soils. *F. fucata* and *F. caryophyllacea*, in contrast, both occur in renosterbos shrubland on stony clay soils. The rather variable *F. caryophyllacea* typically has more or

less prostrate, usually rather broad, typically 10–16 mm wide, lanceolate and obtuse leaves. Populations in the west, centred around Caledon and Bredasdorp, however, have acute and often quite long leaves, 5–9 mm wide, but these are never as narrow or as long as in *F. fucata*. The Bredasdorp populations, which are found on limestone outcrops, were regarded by Goldblatt (1982) as a distinct species, *F. elimensis* L.Bolus, of possible hybrid origin between *F. alba* and *F. caryophyllacea*. Subsequent collections, however, suggest that it is no more than a local edaphic form of *F. caryophyllacea* (Goldblatt & Manning 2000). The possibility that *F. fucata* represents a hybrid between *F. alba* and *F. caryophyllacea* can be discounted since neither of the putative parents has the curious tricuspidate outer bracts of *F. fucata*, nor has either been collected in the immediate vicinity.

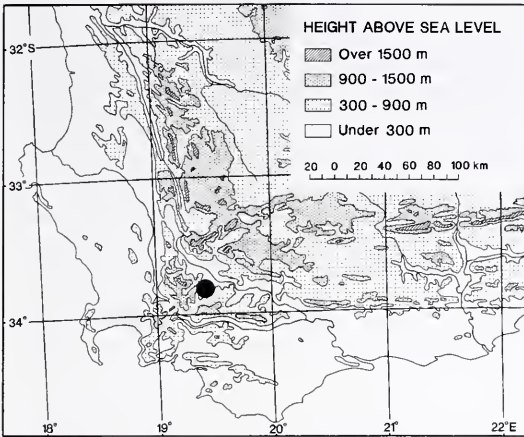


FIGURE 2.—Distribution of both *Freesia fucata* and *Ixia atrandra* in Western Cape.

The more common and widespread *F. refracta* (Jacq.) Klatt, which is well known from the Breede River Valley, also resembles *F. fucata* in its upright habit and narrow leaves and the first collection of the new species was assigned to it in error. *F. refracta* is easily identified, however, by its dry and membranous floral bracts and smaller flowers, 25–35(–40) mm long, with the dorsal tepal more prominent than the relatively small, cordate lower tepals that have their margins conspicuously curved upwards.

#### Additional material examined

WESTERN CAPE.—3319 (Worcester): near Die Hoek, Doornrivier, (–CD), 23-07-1975, Walters 157 (NBG).

#### *Ixia atrandra* Goldblatt & J.C.Manning, sp. nov.

Plantae 250–500 mm altae, cormo globoso tunicis reticulatis, foliis (3)4 lanceolatis basalibus 6–10 mm latis, caule simplice vel 1-ramoso, spica congestis (3)4–10-florum, bracteae scariosae translucentibus 5–6 mm longis, floribus carneis vel cremeis centro atrocolore hypocrateriformibus, tubo perianthii filiforme 6–9 mm longo, tepalis obovatis 11–14 × 6–8 mm, filamentis 2.5–3.0 mm longis ascendentibus, antheris oblongo-sagittatis 5–6 × 1.5–2.0 mm thecis latrorsibus nigris, pollinibus flavis, stylo diviso ad apicem tubi. Figure 3.

TYPE.—Western Cape, Villiersdorp Dist., about 5 km along Doornrivier Road off Villiersdorp-Worcester Road, Farm Die Hoek, (–CD), 3-10-2000, Goldblatt 11604 (NBG, holo.; K, MO, PRE, iso.).

Plants 250–500 mm high. *Corms* globose, 15–20 mm diam., tunics of medium-textured, wiry reticulate fibres. *Cataphylls* membranous, upper one reaching shortly above ground level and then flushed reddish purple. *Leaves* usually 4, sometimes 3, all basal, lanceolate, 6–10 mm wide, usually reaching to about middle of stem, uppermost leaf usually entirely sheathing, margins and midrib hyaline, lightly thickened, plane or lightly twisted in upper half. *Stem* erect, unbranched or with one



FIGURE 3.—*Ixia atrandra*. A, corm and leaves; B, flowering spike; C, anthers and style branches. Scale bar: A–C, 10 mm. Artist: John Manning.

ascending branch, 0.5–0.8 mm diam. below base of spike. *Spike* crowded, (3)4–10-flowered; bracts scariosae, translucent, veins more or less pink above, outer 5–6 mm long, obscurely three-dentate, inner bract about as long as outer or slightly shorter, bicuspidate. *Flowers*

hypocrateriform, pink or rarely cream-coloured, lower third of tepals yellowish or pinkish ochre-coloured with an outer band of deep lilac, unscented; perianth tube filiform and clasping style for its entire length, 6–9 mm long, widened only in upper 1 mm; tepals obovate, somewhat narrowed into short claw below, spreading with distal margins curving upward, 11–14 × 6–8 mm. *Filaments* inserted at apex of tube and occluding throat, blue to brownish, 2.5–3.0 mm long, weakly diverging, free or connate at base; anthers oblong-sagittate, connective broad and thecae restricted to margins, dehiscing laterally, 5–6 × 1.5–2.0 mm (at anthesis), initially erect, later diverging and becoming slightly twisted, black; pollen yellow. *Ovary* ovoid, 2 mm long; style straight and erect, dividing at or just above mouth of tube, branches blue, arching outward, 3–4 mm long, ultimately reaching base of anthers. *Flowering time*: late September and October.

*Distribution and biology*: currently known from two populations in the valley of the Hoeks River in the south-western corner of the Worcester Karoo (Figure 2), *Ixia atrandra* grows on clay soils derived from shales of the Bokkeveld series in open shrubland dominated by the renosterbos, *Elytropappus rhinocerotis*. The flowers of *I. atrandra* display the typical adaptations for pollination by monkey beetles (Scarabaeidae: Rutelinae). These include the congested, subcapitate inflorescence, brightly coloured bowl-shaped flowers with central dark marking, lack of nectar or fragrance and dark anthers. The broadened connectives are part of this syndrome and are matched by remarkably similar sagittate anthers in some beetle-pollinated species of *Babiana*, particularly *B. villosa*, and *B. melanops*.

*History*: this species was first collected in October 1996 as a voucher for studies on beetle-pollination, but the material was inadequate for formal description. A later collection from nearby serves as source of the type material.

*Diagnosis and relationships*: *Ixia atrandra* appears to be most closely allied to *I. rouxii* G.J.Lewis, with which it shares pink flowers with a large central stain, tepals which are narrowed and almost clawed below and black anthers with widened connectives. *I. rouxii* is restricted to the upper reaches of the Breede River and the contiguous Berg River, between Porterville and Wolsley. An unusual feature of both species, but particularly prominently developed in *I. atrandra*, is the presence of dark blue amber-like deposits on the anther connective. These appear to be hardened secretions from the epider-

mis. *I. atrandra* differs from *I. rouxii* in its four (occasionally three), lanceolate leaves 6–10 mm wide, typically unbranched stem (or with a single, ascending branch) and distinctive oblong-sagittate anthers with a broad connective about 1.5 mm wide and the thecae dehiscing laterally. *I. rouxii* typically has five to six (rarely four) almost linear leaves 2–3(–6) mm wide and is distinctive in its sharply spreading branches, and while the anther connectives are widened, they are less than 1 mm wide, and the anthers dehiscence outwards. A third species with pink or white flowers with a prominent dark centre and black anthers, *I. versicolor* G.J.Lewis, is probably also part of this alliance. A local endemic restricted to damp, gravelly renosterfeld flats at Gordon's Bay, it is distinguished from the other two species by its conspicuously thickened, crenulate leaf margins and elliptic tepals that are not narrowed into claws at the base. These three species appear to be geographic segregates restricted to lowland renosterbos shrubland.

#### Additional material examined

WESTERN CAPE.—3319 (Worcester): Brandvlei hills south of Worcester, clay ground in renosterfeld, (–DD), 26-10-1996, Goldblatt 10568 (MO).

#### REFERENCES

- BURCHELL, W.J. 1822. *Travels in the interior of southern Africa*. Reprinted in 1953 by The Batchworth Press, London.
- GOLDBLATT, P. 1982. Systematics of *Freesia* Klatt (Iridaceae). *Journal of South African Botany* 48: 39–91.
- GOLDBLATT, P. 1991. An overview of the systematics, phylogeny and biology of the African Iridaceae. *Contributions from the Bolus Herbarium* 13: 1–74.
- GOLDBLATT, P. & MANNING J.C. 1996. Two new edaphic endemic species and taxonomic changes in *Gladiolus* (Iridaceae) of southern Africa, and notes on Iridaceae restricted to unusual substrates. *Novon* 6: 172–180.
- GOLDBLATT, P. & MANNING, J.C. 1998. *Gladiolus in southern Africa*. Fernwood Press, Cape Town.
- GOLDBLATT, P. & MANNING, J.C. 2000. Cape plants. A conspectus of the Cape Flora of South Africa. *Strelitzia* 9.
- LOW, A.B. & REBELO, A.G. 1996. *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs & Tourism, Pretoria.
- MANNING, J., GOLDBLATT, P. & SNIJMAN, D. in press. *Cape bulbs and their allies*. Timber Press, Oregon.

J.C. MANNING\* and P. GOLDBLATT\*\*

\* National Botanical Institute, Private Bag X7, 7735 Claremont, Cape Town.

\*\* B.A. Krukoff Curator of African Botany, Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri 63166, USA.

MS. received: 2000-10-23.

## HYACINTHACEAE

### THE GENERIC DELIMITATION WITHIN HYACINTHACEAE, A COMMENT ON WORKS BY F. SPETA

#### INTRODUCTION

The definition of genera and the assignment of species to genera within the family Hyacinthaceae, or subfamily Scilleae of the family Liliaceae, have troubled taxonomists since Linnaeus. The group is poor in quali-

tative characters, which has made it difficult to maintain stable genera based on good diagnostic characters. Species have often been moved from genus to genus either due to different opinions on generic delimitation or to misinterpretation of characters. Recently two works by Speta (1998a, b) have appeared that have addressed



generic delimitation within Hyacinthaceae. The first is a paper called 'Systematische Analyse der Gattung *Scilla* L. s.l. (Hyacinthaceae)' (Speta 1998a), the second is the treatment of Hyacinthaceae for 'The families and genera of flowering plants' (Speta 1998b). In these works the author has published a new generic delimitation within the family. As I have worked on sub-Saharan genera of Hyacinthaceae for several years (Stedje 1987, 1988, 1996, 1997, 1998, 2000; Stedje & Thulin 1995, and references therein), both as a biosystematist, and a molecular and floristic taxonomist contributing to new floras, I feel the need to comment on Speta's (1998a, b) new generic delimitations. A review of different taxonomists' opinions on the generic delimitation of Hyacinthaceae is given in Stedje (2001).

#### GENERAL COMMENTS ON THE WORKS OF SPETA (1998a, b)

In Speta (1998a) the family Hyacinthaceae is split into five subfamilies of which four are new: Chlorogaloideae Speta, Oziroëideae Speta, Urgineoideae Speta and Ornithogaloideae Speta. Of these, Oziroëideae, Urgineoideae and Hyacinthoideae are treated further with descriptions and species lists of selected genera. Later DNA analysis excludes Chlorogaloideae from Hyacinthaceae (Pfossner & Speta 1999). Oziroëideae is confined to South America, and I will not deal with it further here. Several of the genera in Speta (1998a) are described as new to science. There is extensive splitting of the 'traditional' genera *Urginea* Steinh. (or *Drimia* Jacq. if a wider generic circumscription is used), *Ornithogalum* L. and *Scilla* L. into newly described genera or reinstated ones. These new genera and generic reinstatements are presented practically without any discussion or justification. The groupings are said to have support in DNA sequence data, but no cladograms or reference to publication of these data are included. Later, in 1999, a paper including a phylogenetic analysis of Hyacinthaceae based on chloroplast DNA sequences appeared (Pfossner & Speta 1999). Unfortunately only a few sub-Saharan species are included here, and for most genera occurring in Africa south of the Sahara, only one species, if any, is analysed. When two or more species are analysed, the genera are, with one exception (*Drimiopsis*), para- or polyphyletic. Furthermore no diagnostic key is provided. A key is given in Speta (1998b), but in that work several of the genera of Speta (1998a) are not included (see below for further comments on this issue). The definition of the genera of Speta's (1998a) new treatment of the family Hyacinthaceae is in other words very unclear. Unfortunately, throughout this work virtually no discussion is given prior to his conclusions, making a meaningful discussion between taxonomists difficult. Furthermore, insufficient details are given of the material studied: no indication of the type of material seen, whether herbarium specimens or living plants, or how many specimens were studied for which species.

#### COMMENTS ON THE SUBFAMILY URGINEOIDEAE

The treatment of this subfamily is rather confusing. Altogether 12 genera are listed as belonging to the subfamily Urgineoideae in the introductory part of Speta (1998a: 53). Two of these genera (*Bowiea* Hook f. and

*Schizobasis* Baker) are not treated further in the part containing generic descriptions, while three genera are described here under subfamily Urgineoideae, but not listed on p. 53: the reinstated genus *Fusifilum* Raf., and the new genera *Igidia* Speta and *Urginavia* Speta. In Speta (1998b) four of the genera of Speta (1998a) are not included. These are *Fusifilum*, *Urginavia*, *Charybdis* Speta and *Ebertia* Speta. They may be included under what in the diagnostic key of Speta (1998b) is referred to as *Urginea* s.l. If the manuscript of Speta (1998b) was completed before the manuscript of Speta (1998a), one would expect to find a key to these critical genera included in the latter. This would help to clarify the distinctions between these genera.

#### *Drimia* sensu lato as a 'Monstergattung'

Botanists have in recent years advocated either a wide (Jessop 1977; Stearn 1978; Stedje 1987, 2000) or a narrow (Stirton 1976; Obermeyer 1980, 1981; Hilliard & Burtt 1982) circumscription of the genus *Drimia*. I have discussed this issue in detail elsewhere (Stedje 1987, 2000), and will not repeat that discussion here. Speta (1998a) calls *Drimia sensu lato* a 'Monstergattung'. He does not define this expression, but his intention is clearly uncomplimentary. *Drimia sensu lato* consists of up to 100 species, a number quite modest when compared with some other Angiosperm genera. There is of course variability within the genus, but not to the extent that it forms a 'rag-bag' taxon with highly heterogeneous elements. The genus is well defined by its winged seeds, an autapomorphy for *Drimia* s.l., and the spurred bracts, a synapomorphy of *Drimia*, *Bowiea* and *Schizobasis*.

#### Where have all the *Drimia* species gone?

Under each of the genera provided with descriptions in Speta (1998a), a list of species is given. The species list of the genus *Ledebouria* Roth is said to be incomplete, but this is not said of any of the other genera. One may therefore interpret those other species lists as intended to be complete. For Africa south of the Sahara this leaves us with 15 species of *Drimia* (*sensu lato*) recognized by either Jessop (1977) or Stedje & Thulin (1995), which have not been taken into account by Speta (1998a). Does this mean that the 15 species are not regarded as belonging to Hyacinthaceae any more, or are they simply forgotten? If so, how can 15 species be neglected and why are names that Jessop (1977) regarded as synonyms of some of these species included? How can one possibly fit these forgotten species into genera when, as mentioned above, the circumscription of the genera is unclear and no key is given?

#### One species or three genera?

In the case of the genus *Avonsera*, discussed later, two apparently discordant species were combined in a single genus. There are also, in Speta's work (Speta 1998a), cases where apparently closely related species are segregated into different genera. Four synonyms of *Drimia modesta* (Baker) Jessop (*sensu* Jessop 1977) have here been placed in three different genera, *Urgineopsis* Compton, *Thuranthos* C.H.Wright and *Fusifilum*. The

species are *U. salteri* Compton, *T. revoluta* (Duthie) Speta, *F. dregei* (Baker) Speta and *F. gracilis* (Duthie) Speta. As already mentioned, different botanists must be allowed to have different opinions as long as appropriate documentation is presented. This is, however, not done here.

#### COMMENTS ON THE SUBFAMILY ORNITHOGALOIDEAE

Several of the genera recognized in this subfamily have previously been included in the genus *Ornithogalum* L. The sub-Saharan *Ornithogalum* is, for example, split into the genera *Stellarioides* Medicus, *Coilonox* Raf., *Eliokarmos* Raf. and *Zahariadia* Speta, a new genus which is possibly monotypic. The first three genera appear to coincide in part with Obermeyer's (1978) subgenera even if it seems that only a part of Obermeyer's subgenus *Urophyllon* is accommodated by the genus *Stellarioides*. Where the rest of the subgenus *Urophyllon* is to be placed, is unclear. The subfamily Ornithogaloideae is split into the tribes Dipsacidae and Ornithogaleae. These tribes are based on seed characters, which are mainly quantitative, and they key out at lead 13 in Speta (1998b). The alternatives of this lead are not very clear and it should be possible to simplify them. The same applies to lead 12 which also refers to seed characters and is even less clear. The two alternatives of lead 13 are, for example: 1) Seeds flattened, orbiculate, D-shaped, or elongate; tepals green, brown or yellow, or whitish, with a green streak, versus 2) Seeds minute, comma-shaped, glabrous or shortly pilose, rarely edged, or large, elongate, with irregular edges, or globose to ellipsoid; tepals white, with or without a green stripe, or yellow or orange. Within this subfamily both tribes and genera are defined largely on the basis of quantitative characters of the seeds. For me it is difficult to understand the necessity of this excessive splitting. Take, for example, three species, the sub-Saharan *O. tenuifolium* F. Delaroché, the Moroccan *O. sessiliflorum* Desf. and the Mediterranean *O. narbonne* L. These three species are very similar in all characters, except possibly for some differences in quantitative morphological characters between the two Mediterranean species, and in the Mediterranean species having more turgid seeds than *O. tenuifolium*. I am not absolutely sure in which genera to put these species as Speta does not treat them specifically. *O. sessiliflorum* in particular, does not quite fit in anywhere. As I interpret Speta's new system, however, these three species are put into two different tribes, Dipsacidae and Ornithogaloideae, and three different genera *Stellarioides*, *Cathissa* Salisbury and *Lonocmelos* Raf. respectively.

#### COMMENTS ON THE SUBFAMILY HYACINTHOIDEAE

For this subfamily the treatment is far less confusing than for subfamily Urgineoideae, but there are some points to be commented on. Altogether 38 genera are listed as belonging to the subfamily Hyacinthoideae. Of these, just 21 are treated with full descriptions in the following text, and there is no obvious reason for omitting the 17 others. One of these 17 genera, *Namophila* U. & D. Müller-Doblies, is not mentioned at all in Speta (1998b).

#### The genus *Avonsera* Speta

The new genus *Avonsera* Speta is based on two species, *A. convallarioides* (Perrier) Speta and *A. lachenalioides* (Baker) Speta (Speta 1998a). *A. convallarioides* is a species endemic to Madagascar, originally described in the genus *Ornithogalum*. Obermeyer (1978), in endorsing the placement of the species in *Ornithogalum*, writes: 'the characters of the flowers, capsules and seeds agree with *Ornithogalum*'. *A. lachenalioides* is confined to KwaZulu-Natal and Eastern Cape and was placed in *Drimiopsis* by Jessop (1972). It appears strange to base a genus on two species with a rather disjunct distribution that have recently been placed in two distinctly related genera by two competent South African botanists. There may of course be good reasons for doing so, but one would expect a short discussion of the issue. I have not seen such in either Speta (1998a) or Speta (1998b).

#### CONCLUSION

Speta's (1998a, b) treatment of Hyacinthaceae is an unfortunate case of excessive splitting of the family which will create more confusion than clarity. Many of the genera, especially the new ones are monotypic. His conclusions have no clear proven basis, neither in cladistic analyses, nor in more classical criteria for generic delimitation such as giving emphasis to qualitative morphological characters and using minor characters only to preserve genera already recognized. A full review on this issue is given by Stuessy (1990, and references herein). Speta's generic delimitation might fit the Mediterranean and European species of the family, but I see substantial difficulties when applied to sub-Saharan species.

#### REFERENCES

- HILLIARD, O.M. & BURTT, B.L. 1982. Notes on some plants of southern Africa chiefly from Natal: IX. *Notes from the Royal Botanic Garden Edinburgh* 40: 247–298.
- JESSOP, J.P. 1972. Studies in the bulbous Liliaceae in South Africa: 2. *Drimiopsis* and *Resnova*. *Journal of South African Botany* 38: 151–162.
- JESSOP, J.P. 1977. Studies in the bulbous Liliaceae in South Africa: 7. The taxonomy of *Drimia* and certain allied genera. *Journal of South African Botany* 43: 265–319.
- OVERMEYER, A.A. 1978. *Ornithogalum*: a revision of the southern African species. *Bothalia* 12: 323–376.
- OVERMEYER, A.A. 1980. The status of *Urginea epigea*. *Bothalia* 13: 139.
- OVERMEYER, A.A. 1981. A reappraisal of *Urginea altissima*. *Bothalia* 13: 452, 453.
- PFOSSER, M. & SPETA, F. 1999. Phylogenetics of Hyacinthaceae based on plastid DNA sequences. *Annals of the Missouri Botanical Garden* 86: 852–875.
- SPETA, F. 1998a. Systematische Analyse der Gattung *Scilla* L. s.l. (Hyacinthaceae). *Phyton (Horn)* 38: 1–141.
- SPETA, F. 1998b. Hyacinthaceae. In K. Kubitzki, *The families and genera of vascular plants* 3: 261–285. Springer-Verlag, Berlin.
- STEARNS, W.T. 1978. Mediterranean and Indian species of *Drimia* (Liliaceae): a nomenclatural survey with special reference to the medicinal squill, *D. maritima* (syn. *Urginea maritima*). *Anuales Musei Goulandris* 4: 199–210.
- STEDJE, B. 1987. A revision of the genus *Drimia* Jacq. (Hyacinthaceae) in East Africa. *Nordic Journal of Botany* 7: 655–666.
- STEDJE, B. 1988. *Cytotaxonomic studies within Hyacinthaceae with special emphasis on karyotype evolution*. Ph.D. thesis, University of Oslo, Norway.



STEDJE, B. 1996. Hyacinthaceae. In R.M. Polhill, *Flora of tropical East Africa*. Balkema, Rotterdam.

STEDJE, B. 1997. Hyacinthaceae. In S. Edwards, Sebsebe Demissew & I. Hedberg, *Flora of Ethiopia and Eritrea* 6: 138–147. The National Herbarium, Addis Ababa.

STEDJE, B. 1998. Phylogenetic relationships and generic delimitation of sub-Saharan *Scilla* L. (Hyacinthaceae) and allied African genera as inferred from morphological and DNA sequence data. *Plant systematics and evolution* 211: 1–11.

STEDJE, B. 2000. Evolutionary relationships of the genera *Drimia*, *Thuranthos*, *Bowiea* and *Schizobasis*, elucidated by morphological and chloroplast DNA sequence data. In K.L. Wilson & D.A. Morrison, *Proceedings of the Second International Conference on Comparative Biology of the Monocotyledons*, Sydney, Australia, 1998, Vol. 1. *Systematics and evolution of Monocots*: 414–417. CSIRO Publishing, Collingwood, Australia.

STEDJE, B. in press. Generic delimitation of Hyacinthaceae, with special emphasis on sub-Saharan genera. *Proceedings of the 16<sup>th</sup> AETFAT Congress, 28 August to 2 September 2000. Systematics and geography of plants* 71.

STEDJE, B. & THULIN, M. 1995. Synopsis of Hyacinthaceae in East and North-East Africa. *Nordic Journal of Botany* 15: 591–601.

STIRTON, C.H. 1976. *Thuranthos*: notes on generic status, morphology, phenology and pollination biology. *Bothalia* 12: 161–165.

STUESSY, T.F. 1990. *Plant taxonomy: the systematic evaluation of comparative data*. Columbia University Press, New York.

B. STEDJE\*

\* University of Oslo, Botanical Garden and Museum, P.O. Box 1172 Blindern, N-0318 Oslo, Norway. E-mail: brita.stedje@nhm.uio.no  
MS. received: 2000-11-02.

DENNSTAEDTIACEAE–PTEROPSIDA

HYPOLEPIS VILLOSO-VISCIDA NEW TO THE FLORA OF SOUTHERN AFRICA

Recently, a *Hypolepis* collection from Genadendal in the Western Cape, differing from *H. sparsisora* (Schrad.) Kuhn came to my attention. This collection differs in the distribution of hairs on the lamina, the presence of glandular and receptacular hairs, and larger stomata and spores. To determine whether the plants may be recent introductions and to determine the size of the population, I have subsequently visited the location. A review of herbarium collections revealed that this species, although scarce, also occurs elsewhere in South Africa, but has always been erroneously determined as *H. sparsisora*. A morphological study showed that these plants are synonymous with *H. villosa-viscida* (Thouars) Tardieu, a species also occurring on the South Atlantic island groups of Gough and Tristan da Cunha.

Key to the South African species of *Hypolepis*

- Lamina with acicular and oblong hairs confined to axes and veins; receptacle nude; stomata 28–(37.11)–46 µm long; spores 24–(29.04)–38 × 15–(19.63)–26 µm . . . . *H. sparsisora*
- Lamina with acicular and glandular hairs (rarely also oblong hairs) on axes, veins and lamina surfaces; receptacle usually with uniseriate hairs; stomata 38–(50.33)–64 µm long; spores 32–(38.01)–46 × 20–(23.95)–30 µm . . . . . *H. villosa-viscida*

***Hypolepis villosa-viscida*** (Thouars) Tardieu, *Flore de Madagascar et de Comores* 5,1: 6, fig. 1, t. 3–5 (1958).

*Polypodium villosa-viscidum* Thouars: 33: (1808). Type: Tristan d’Acunha, Aubert du Petit-Thouars s.n. (P, holo.).

*Cheilanthes viscosa* Carmich.: 511 (1818). Type: Tristan da Cunha, Carmichael s.n. (K, holo.; BM, iso.).

Specimens examined

EASTERN CAPE.—3225 (Somerset East): Somerset East, Boschberg, 760 m, Nov. 1875, (–DA), MacOwan 1575 (SAM).

WESTERN CAPE.—3418 (Simonstown): Orange Kloof, W-facing slopes, ± 220 m, 24 Nov. 2000, (–BD), Roux 3023 (NBG). 3419 (Caledon): Genadendal, Baviaans River, north bank alongside road upstream of weir, 280 m, 2 June 2000, (–BA), Boucher 6515 (NBG); Genadendal, Baviaans River, above 2nd weir, ± 300 m, 7 July 2000, (–BA), Roux 3007, 3009, 3010, 3011 (NBG).

REFERENCES

CARMICHAEL, D. 1818. Some account of the island of Tristan da Cunha and its natural productions. *Transactions of the Linnean Society of London* 12: 483–513.

TARDIEU-BLOT, M.L. 1958. Polypodiacees (sensu lato), Dennstaedtiacees–Aspidiacees. In H. Humbert, *Flore de Madagascar et des Comores*, Fam. 5,1: 1–391. Paris.

THOUARS, L.M. AUBERT DU PETIT. 1808. *Esquisse de la flore de l’Isle de Tristan d’Acunha*. Paris.

J.P. ROUX\*

\* Compton Herbarium, National Botanical Institute, Private Bag X7, 7735 Claremont, Cape Town.  
MS. received: 2000-09-01.

PORTULACACEAE

TALINUM PANICULATUM, A NATURALIZED WEED IN SOUTH AFRICA

*Talinum* Adans. is a medium-sized genus of semi-succulent herbs and shrubs with annual branches sprouting from a perennial base with tuberous roots. These fleshy underground parts tend to draw the attention of succulent plant collectors, who would include the plants in the broadly conceived group of caudiciform succulents (Smith *et al.* 1997). About 50 species are recognized in

*Talinum* (Von Poellnitz 1934), occurring mostly in Africa, Australia, parts of Asia and North and South America. In the African species the pedicels are always swollen below the fruit and are more or less recurved when fruiting (Tölken 1969). Five species are indigenous in South Africa, restricted to summer rainfall areas (Tölken 1969). *Talinum paniculatum* (Jacq.) Gaertn. is





FIGURE 4.—*Talinum paniculatum*: A, habit of plant in fruit,  $\times 0.6$ ; B, open flower as seen from above,  $\times 5$ ; C, flower in side view with one petal removed,  $\times 5$ ; D, capsular fruit  $\times 3.7$ ; E, dissected capsule showing multiple seeds with free-central placentation,  $\times 3.7$ . Artist: Marietjie Steyn.

one of two alien species of Portulacaceae that has become naturalized in the flora of southern Africa (Jordaan 1997). This report forms part of ongoing efforts to document, describe and illustrate naturalized succulents in southern Africa.

Known as 'American star-flowers' or 'pink star-flowers', *T. paniculatum* is native to the plains from Texas to Arizona, south and central Florida, Mexico, the West Indies and South America (Gray 1895; Von Poellnitz 1934). Its occurrence in Sri Lanka and in Malaysia (Singapore), Indonesia (Java), Thailand and China, probably resulted from early cultivation and a subsequent escape into the wild (Von Poellnitz 1934). In South Africa, the species was recorded about thirty years ago as a garden escape in a few places, but did not then seem to spread as a weed (Tölken 1969). It has since become established as a troublesome weed in domestic and pub-

lic gardens in and around Pretoria and along the Western Cape coast with its Mediterranean-type climate. The plants are not easy to eradicate; although the aerial parts tend to die off in winter, the species is perennial through a thickened rhizome and fleshy roots (Figure 4). It also flowers and fruits prolifically and produces a multitude of wind-dispersed microscopic seeds that spread and germinate easily.

2406000-600 *Talinum paniculatum* (Jacq.) Gaertn., *De fructibus et seminibus plantarum* 2: 219, t. 128 (1791); Poelln.: 1 (1934); Adams: 267 (1972). Type: not designated.

*Portulaca paniculata* Jacq.: 22 (1760) non L.: 640 (1762); Jacq.: 148 (1763); Jacq.: 71, t. 151 (1772-1773).

*Portulaca patens* L.: 242 (1771); *Ruclingia patens* (L.) Ehrh.: 135 (1788); *Helianthemoides patens* (L.) Med.: 95 (1789); *Talinum patens* (L.) Willd.: 863 (1799); A.Gray: 265 (1895); *Claytonia patens* (L.) Kuntze: 56 (1891). Type: not known.

*T. reflexum* Cav.: 1, t. 1 (1791); Sims: t. 1543 (1813); *Portulaca reflexa* (Cav.) Haw.: 141 (1803); *Claytonia reflexa* (Cav.) Kuntze: 57 (1891). Type: not known.

*T. sarmentosum* Engelm.: 153 (1850); *Claytonia sarmentosum* (Engelm.) Kuntze: 57 (1891); *T. reflexum* var. *sarmentosum* (Engelm.) Small: 415 (1903); *T. paniculata* var. *sarmentosum* (Engelm.) Poelln.: 123 (1933). Type: not known.

For a more complete list of synonyms, see Von Poellnitz (1934: 11).

Glabrous herb with annual branches developing from perennial base with tuberous roots. *Stems* erect, terete, up to 0.4 m long. *Leaves* alternate to subopposite, petiolate, glabrous, somewhat succulent; blade obovate or oblanceolate, varying to spatulate, 40–110  $\times$  15–45 mm, apex acute to rounded, margins entire; petiole swollen at base; exstipulate. *Inflorescence* terminal, panicle-like, compound, dichasial, up to 450 mm long; bracteoles minute,  $\pm 1$  mm long, membranous, lanceolate, early deciduous. *Flowers* bisexual, star-shaped,  $\pm 2.5$  mm diam., opening mid-afternoon, closing at dusk; pedicels filiform,  $\pm 3.5$  mm long. *Sepals* 2, opposite, green, glabrous, 1 mm long, acuminate, recurved in open flower. *Petals* 5, oblong with rounded apices, spreading, pink to rose-coloured, tardily deciduous from capsule. *Stamens* numerous,  $\pm 1.5$  mm long; filaments dorsifixed; anthers opening with slits. *Ovary* superior, spherical, 1 mm diam., unilocular, multi-ovular, placentation free-central; style terete, articulating at base; stigma with 3 spatulate lobes. *Capsule* spherical, 2.5 mm diam., thin-walled, bright orange when young, turning to brown during ripening, opening with 3 longitudinal slits. *Seeds* numerous, lens-shaped, 0.8–0.9 mm long, short-beaked with small, white aril at hilum, seed coat shiny black, tuberculate. Figure 4. *Chromosome number* unknown. *Flowering time*: September to April.

Vouchers: Barker 4439 (PRE); Barrett 333 (PRE); Pegler 1587 (PRE); G.F. Smith & E.M.A. Steyn 4 (PRE).

Illustrations: Jacq.: t. 151 (1772–1773) as *P. paniculata*; Cav.: t. 1 (1791), as *T. reflexum*; Sims: t. 1543 (1813), as *T. reflexum*.

Common names: American star-flower (Von Poellnitz 1934: 1) or pink star-flower (Gray 1895).

REFERENCES

ADAMS, C.D. 1972. *Flowering plants of Jamaica*: 267. University Press, Glasgow.

CAVANILLES, A.J. 1791. *Talinum reflexum*. *Icones et descriptiones plantarum* 1: 1, t. 1. (Reprint 1965). Cramer, New York.

EHRHART, J.F. 1788. *Beiträge zur Naturkunde* 3: 135.

ENGELMANN, G. 1850. Portulacaceae. *Boston Journal of Natural History* 6: 153.

GAERTNER, J. 1791. *Talinum* Adans. *De fructibus et seminibus plantarum* 2: 219, t. 128, fig.13. Guiljelmi Henrici Schrammii, Tubinge.

GRAY, A. 1895. *Talinum patens* Willd. *Synoptical flora of North America* 1, Part 1, Fascicle 1: 265. American Book Co., New York.

HAWORTH, A.H. 1803. *Portulacca* (sic.). *Miscellanea naturalia*: 141. Taylor, London.

JACQUIN, N.J. 1760. *Enumeratio systematica plantarum*: 22. Lugduni, Batavorum.

JACQUIN, N.J. 1763. *Selectarum stirpium americanarum historia*: 148. (1971 Facsimile). Hafner, New York.

JACQUIN, N.J. 1772–1773. *Hortus botanicus vindobonensis* 2: 71, t. 151. Kaliwoda, Vindobonae.

JORDAAN, M. 1997. Portulacaceae. In G.F. Smith, E.J. van Jaarsveld, T.H. Arnold, F.E. Steffens, R.D. Dixon & J.A. Retief, *List of southern African succulent plants*: 145. Umdaus Press, Pretoria.

KUNTZE, O. 1891. Portulacaceae. *Revisio generum plantarum* 1: 56, 57. Kommissionen, Leipzig.

LINNAEUS, C. 1762. *Species plantarum*, Vol. 1, edn 2: 640. Laurentius Salvius, Stockholm.

LINNAEUS, C. 1771. *Mantissa plantarum*: 242. (1961 Facsimile). Cramer, Weinheim.

MEDIKUS, F.K. 1789. *Philosophische Botanik* 1: 95. Neue Hof- und Akademische Buchhandlungen, Mannheim.

SIMS, J.K. 1813. *Talinum reflexum*. *Reflex-flowered Talinum*. *Curtis's Botanical Magazine* 37: t. 1543.

SMALL, J.K. 1903. *Talinum* Adans. *Flora of the southeastern United States*: 415. Small, New York.

SMITH, G.F., VAN JAARSVELD, E.J., ARNOLD, T.H., STEFFENS, F.E., DIXON, R.D. & RETIEF, J.A. (eds). 1997. *List of southern African succulent plants*: ii. Umdaus Press, Pretoria.

TÖLKEN, H.R. 1969. The genus *Talinum* (Portulacaceae) in southern Africa. *Bothalia* 10: 19–28.

VON POELLNITZ, K. 1933. Zur Kenntnis der Gattung *Talinum* Adans. (Portulacaceae). *Berichte der Deutschen Botanischen Gesellschaft* 51: 123.

VON POELLNITZ, K. 1934. Monographie der Gattung *Talinum* Adans. *Repertorium specierum novarum regni vegetabilis* 35: 1–34.

WILLDENOW, C.L. 1799. *Talinum patens*. *Species plantarum* 2, Part 2: 863. Nauk, Berlin.

E.M.A. STEYN\* and G.F.SMITH\*

\* National Botanical Institute, Private Bag X101, 0001 Pretoria.  
MS. received: 2001-04-06.

ZAMIACEAE

ENCEPHALARTOS RELICTUS: A NEW SPECIES FROM SOUTHERN AFRICA

In a continuing attempt to document biodiversity in the African Zamiaceae, an evaluation of material from Swaziland (Hurter 1993) has led to the conclusion that there exists a distinct undescribed species, that may already be extinct in the wild. Due to the fact that no new material has been forthcoming in more than 20 years it was decided that this relict species should be described for posterity.

**Encephalartos relictus** P.J.H.Hurter, sp. nov., *E. heenanii* R.A.Dyer foliis rigidis caesiis similis, sed pinnis linearo-lanceolatis adscendentis inflexis, microsporophyllis ovatis tomentosis, et habitatione nemorali differt.

TYPE.—Swaziland: Siteki, Farm Muti-Muti, (leaf and part of male cone), 15-03-1971, J.J.P. du Preez s.n. (PRE33123, holo.).

Plant arborescent, suckering from base. *Trunk* up to 2.5 m long, 400–450 mm diam., leaf bases persistent, crown and cataphylls tomentose, golden brown, becoming subglabrous with age. *Leaves* numerous in dense, spreading crown, rigid, subsessile, waxy blue-grey in colour, 1.0–1.2(–1.4) m long, pinnae ascending. *Petiole* apparent, woolly, becoming subglabrous with age, except pulvinus. *Rachis* straight, woolly, becoming subglabrous with age, apex slightly incurved. *Pinnae* woolly, becoming glabrous with age, entire, veins raised abaxially, margins slightly thickened, inflexed, directed towards apex of leaf at an angle of  $\pm 60^\circ$  to rachis, opposing leaflets inflexed, set at an angle of  $\pm 40^\circ$  to each other and orientated succubously, proximal pinnae gradually reduced to a few prickles. *Median leaflets* oblong-lanceolate, pungent, 200–250  $\times$  14–17 mm, margins entire, 20–25 prominent veins abaxially.

*Strobili* glabrous, scale facets smooth, light greenish yellow. *Megastrobili* unknown. *Microstrobili* 1–3 per trunk, subconical, 200–240  $\times$  120–150 mm, stalked on peduncle 30–50 mm long. *Median microsporophylls* spreading, more or less at right angles to axis, lamina oblong, tapering to base,  $\pm 35$ –40 mm long, 30–35 mm wide and 10–15 mm high, margins contracted to pedicel, bulla with terminal facet projecting slightly as drooping lip-like structure, edges verrucose, microsporangia separated from lateral margins. Figure 5.

Diagnostic features and affinities

*E. relictus* superficially resembles *E. heenanii* R.A.Dyer (Dyer 1972), on account of its stiff waxy blue-grey leaves and pinnae with the veins prominently raised abaxially. However, it differs markedly from *E. heenanii* in morphology, habit and habitat. *E. relictus* used to occur in mixed deciduous woodland (Figure 6), whereas *E. heenanii* occurs in high rainfall, high altitude, sour grassland. The important morphological differences between the two species are summarized in the following table.

TABLE 1.—Differences between *E. heenanii* and *E. relictus*

	<i>E. heenanii</i>	<i>E. relictus</i>
Pinnae	ovate-lanceolate markedly deflexed from rachis	oblong-lanceolate inflexed
Leaves	inflexed, crown wine-glass-shaped	straight, crown spreading
Microstrobili	ovate, tomentose	subconical, glabrous (Figure 7)

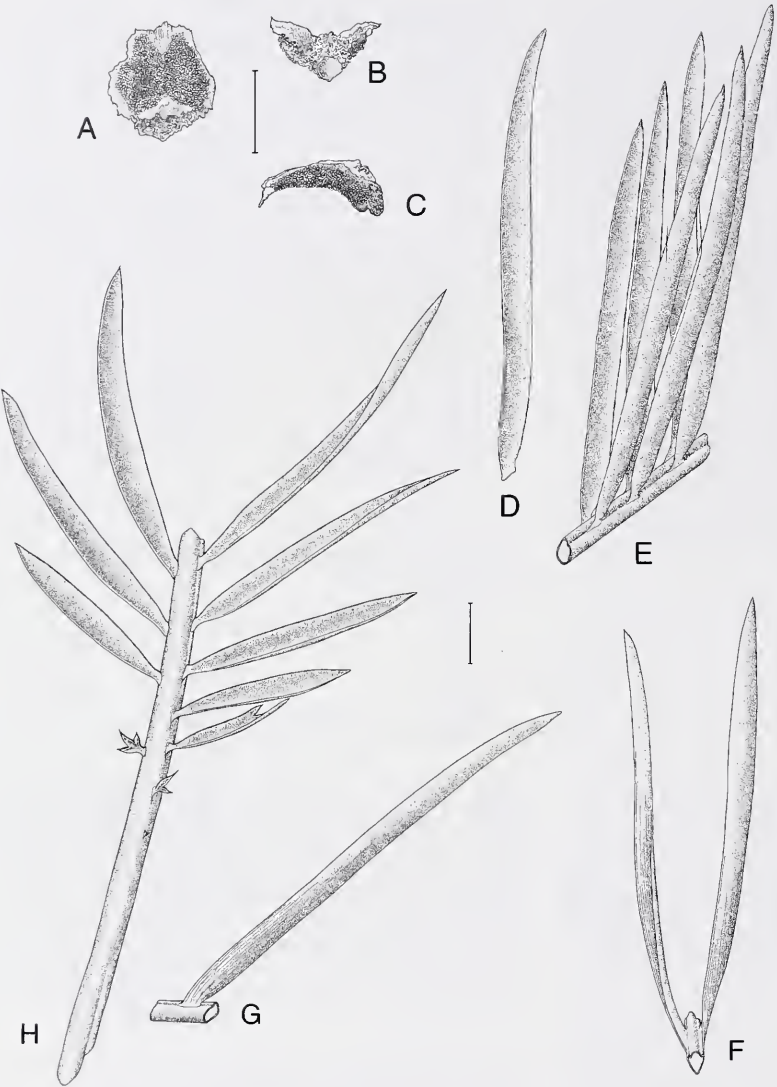


FIGURE 5.—*Encephalartos relictus* P.J.H. Hurter. A–C, microsporophyll: A, abaxial view; B, frontal view; C, side view. D, median pinna, adaxial view; E, F, median section of leaf showing inflexed nature of pinnae; G, median pinna, abaxial view and orientation towards apex of leaf; H, petiole and proximal pinnae. Scale bars: A–H, 30 mm. Artist: S.J. Burrows.



FIGURE 6.—*Encephalartos relictus* in habitat (photo: J.J.P. du Preez).



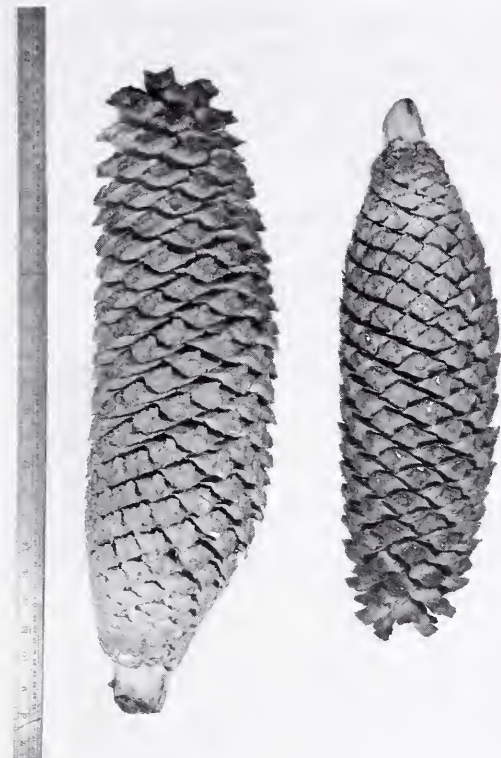


FIGURE 7.—*Encephalartos relictus* microstrobili (photo: J.J.P. du Preez).

#### Geographical distribution

As far as is known, this species used to grow only at a single locality in Swaziland, at an altitude of 1 000 m (Figure 8). Its present conservation status code (IUCN 1994) is ExW.

#### Other specimen examined

SWAZILAND.—Siteki, Farm Muti-Muti, P.J.H. Hurter 95s/h1 (GLOW).

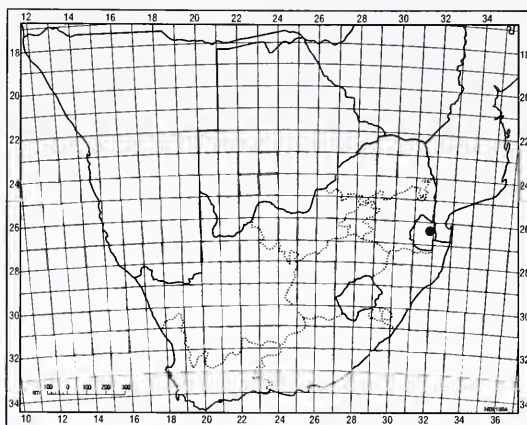


FIGURE 8.—Known former distribution of *Encephalartos relictus*. The species no longer occurs in the wild (Red List category ExW).

#### ACKNOWLEDGEMENTS

The research of which this publication is a result was financed by the National Botanical Institute. The artist is Sandie Burrows. The director of the National Botanical Institute (PRE) is thanked for permission to use the accompanying photographs.

#### REFERENCES

- DYER, R.A. 1972. A new species of *Encephalartos* from Swaziland. *Bothalia* 10: 539–546.
- HURTER, P.J.H. 1993. Focus on: *Encephalartos heenanii*. *Encephalartos* No. 40: 4–7.
- IUCN 1994. IUCN Red List Categories. IUCN, Gland, Switzerland.

P.J.H. HURTER\* and H.F. GLEN\*\*

\* Lowveld National Botanical Garden, P.O. Box 1024, 1200 Nelspruit, South Africa.

\*\* National Botanical Institute, Private Bag X101, 0001 Pretoria. MS. received: 2000-03-08.

### NEW RECORDS AND DISTRIBUTIONAL DISJUNCTIONS FROM SOUTH AFRICA, ZIMBABWE AND MOZAMBIQUE

#### INTRODUCTION

Floristic evidence for the continuity of vegetation types often lingers in the form of relicts which inhabit isolated refugia. This evidence can be ambiguous in families with adaptations to long distance dispersal. However, in a number of families, vicariance is the only logical explanation for distributional anomalies. This paper records disjunctions in Acanthaceae, Thymelaeaceae and Lamiaceae, all families renowned for the parochial dispersal of seeds and fruits.

#### ACANTHACEAE

Recent research (Edwards & Harrison 1998) revealed a distributional extension to the range of *Pseuderanthemum hildebrandtii* Lindau (Acanthaceae) which reiterates the floristic links between tropical East Africa and northern KwaZulu-Natal. This species is associated with woodlands and provides compelling evidence of the continuity of dense savanna and forest habitat between the eastern seaboard of South Africa and populations in Tanzania. Acanthaceae have explosive fruits with elastic

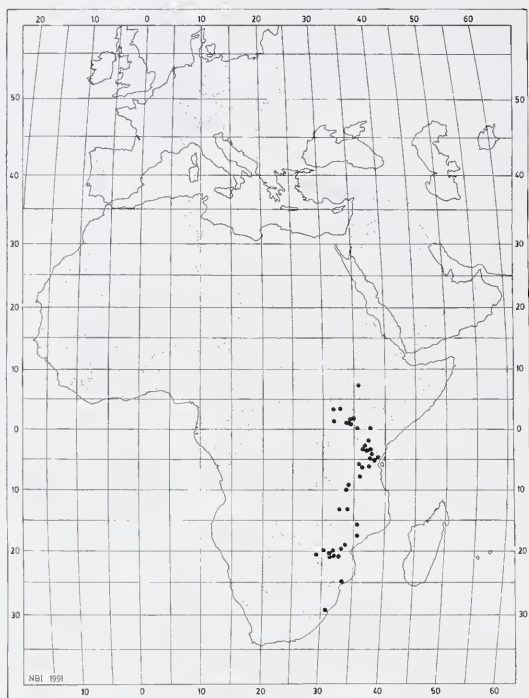


FIGURE 9.—Recorded distribution of *Metarungia pubinervia*.

funicles (retinaculae) which are effective in local dispersal but are not suitable for long distance dispersal. It was therefore exciting to find another species of forest Acanthaceae, *Metarungia pubinervia*, which corroborates the above pattern.

According to Baden (1981) the genus *Metarungia* comprises three species, two of which, *M. galpinii* (Baden) Baden and *M. longistrobus* (C.B.Clarke) Baden, are endemic to the subcontinent and the type species, *M. pubinervia* (T.Anderson) Baden, is common in tropical East Africa, but has been recorded in southern Mozambique. The phylogeography of *Metarungia* is intriguing in its inconsistency. *M. longistrobus* occurs in association with forest patches in Mpumalanga, southwest Mozambique and Swaziland and, although the species occasionally ventures into stony grasslands with steep slopes, it is unable to survive fire. Similarly, *M. galpinii* is limited to forest habitats around East London, Eastern Cape, but in cultivation both species are more vigorous in exposed situations. There is no doubt that *M. galpinii* and *M. longistrobus* are sister species, the plants have very similar habit, creamy mustard corollas of similar size, similar androecia, gynoecia, inflorescence structure, fruits and seeds. The major differences which separate them relate to indumental differences, bract size, the loss of bracteoles in *M. galpinii*, and the much smaller calyces of *M. longistrobus*. If one accepts that these are vicarious sister species, then their current parochial distributions (Baden 1981) are remnants of the range of their hypothetical parent. This distributional disjunction provides compelling evidence of an ancient forest link between the afro-montane and riverine forests of Mpumalanga, in the north, and the coastal forests

around East London. Neither species has yet been recorded from the intervening forests of KwaZulu-Natal. Extending this line of reasoning to *M. pubinervia* (Figure 9), allows one to postulate past forest linkage between the southern (Krantzklouf) and northern (Tanzanian) populations.

***Metarungia pubinervia*** (T.Anderson) Baden in Kew Bulletin 39: 638 (1984). *Macrorungia pubinervia* (T.Anderson) C.B.Clarke: 255 (1900); Brenan & Greenway: 13 (1949); Dale & Greenway: 17 (1961); Agnew: 607 (1974); Baden: 148 (1981). *Rungia pubinervia* T.Anderson: 46 (1863). *Himantochilus pubinervia* (T.Anderson) Lindau: 373 (1895a). *Anisotes pubinervis* (T.Anderson) Heine: 189 (1966). Type: Malawi, Mt Chiradzulu, Kirk s.n. (K!, lecto.).

*Himantochilus marginatus* Lindau: 60 (1894); Lindau: 346 (1895b). Type: Tanzania, Usambara. Holst 9063 (HBG, lecto.; G, P, M, Z, W).

Shrubs 1–5 m tall; stems initially hairy, often with aerial roots. Leaves elliptic to narrowly obovate, 140–250 × 40–100 mm, sparsely strigose to glabrescent, apex acute to acuminate, veins sericeous when young, becoming glabrescent, acarodomatia present in vein axes; petiole 15–60 mm long. Inflorescences axillary, usually on leafless stems, 15–50 mm long; peduncles seldom exceeding 2 mm long, glabrescent; bracts tightly imbricate; lower bracts sterile, ovate to elliptic, 5–12 × 3–5 mm, apex slightly acuminate, margin slightly scarious; fertile bracts broadly ovate, 10–15 × 6–9 mm, apex acuminate, margin markedly scarious, pink to red; bracteoles absent. Calyx 9–12 mm long, membranous; lobes pink, 7–9 × 2–3 mm, midveins green, extending into an apiculus. Corolla cylindrical, red; tube 9–11 mm; upper lip 28–31 × 8 mm, cucullate; lower lip coiled at anthesis, 20 × 3 mm. Stamens 2; filaments 20 mm long, cream-coloured, epipetalous, attached in throat; anther thecae oblique, 2–3 mm long. Ovary 2.5–3.0 × 1.5 mm, glabrescent; style 27–30 mm long, glabrous; nectariferous cupule 1–2 mm tall.

In the Krantzklouf population bracteoles were not observed. However, Baden (1981) records the occasional occurrence of linear bracteoles in tropical populations of *M. pubinervia*. In a generic context, the fugitive occurrence of bracteoles in this species is interesting because this character is used to discriminate between *M. longistrobus* and *M. galpinii*.

Throughout its range *M. pubinervia* occurs between 500 and 2 000 m in riverine and evergreen forest, in light shade. The Krantzklouf population is limited to scree along the base of sandstone cliffs. This unstable substrate reduces the establishment of the tree canopy and maintains the higher light intensities in which the species thrives. This population is fairly large (several hundred adult individuals and an abundance of seedlings) and the plants, although conspicuous, are in a fairly remote section of the gorge and have consequently escaped detection.

#### *Specimen examined*

KWAZULU-NATAL.—2930 (Pietermaritzburg): Krantzklouf Nature Reserve, (–DD), Styles, Johnson & Edwards s.n. (K, NH, NU, PRE).



THYMELAEACEAE

The poor capacity for long distance dispersal is common to a number of families, including Thymelaeaceae. Most South African species of *Gnidia* are grassland inhabitants and, due to the continuity of this habitat, relatively few species display disjunct distributions. *Gnidia denudata* is anomalous in this regard. The species has a tree-like habit and occurs in forest margins, lacking the resprouting caudex which enables grassland taxa to survive fire. The remaining *Gnidia* species are shorter, multi-stemmed shrubs or herbs inhabiting fynbos, grassland or subalpine zones. Lindley (1823) described *G. denudata*, the specific epithet referring to the lack of lamina hairs, which usually distinguishes this species from *G. imbricata* L.

***Gnidia denudata* Lindl.**, Botanical Register 9: t. 757 (1823); Spreng.: 152 (1827); Meisn.: 441 (1840); Drège: 123 (1843); Meisn.: 585 (1857); C.H.Wright: 63 (1915). *G. tomentosa* sensu Hook.: t. 2761 (1827) non Thunb. Type: South Africa, in nemorosis prope George, IV. C. b., Drège (NY, iso!).

Shrub to small tree up to 3 m tall (Wright 1915). Branches slender, erect to laxly arching, and pilose when young, glabrescent with age. Leaves simple, exstipulate, 3–5-veined from base, clustered towards ends of branches, pilose when young. Inflorescences terminal or lateral clusters comprising 4–6 tubular, pale flowers; involucre bracts green, foliaceous, smaller than leaves, as long as hypanthia. Flowers 4-merous, sweetly scented at night; petaloid scales paired, narrowly oblong, alternating with calyx lobes. Stamens 8, in 2 rows in mouth and throat of tube.

The pilose young stems, leaves and flowers, together with the comparatively rare condition of broadly foliaceous leaves that are three to five-veined from the base, distinguish this species.

Some confusion has arisen regarding the nomenclature of *G. denudata* and *G. tomentosa*. Linnaeus (1753) described *G. tomentosa* from the mountains of the Cape Peninsula and Worcester areas. This shrub attains about 1 m in height and bears slightly scabrid, semi-coriaceous leaves which have verrucose surfaces: a result of raised epidermal cells around the bases of hairs. Flowers, ± 6, are produced only in terminal inflorescences. Hooker (1827) misapplied *G. tomentosa* to plants of *G. denudata*. Leaves of *G. denudata* lack the coarse texture and verrucose surfaces typical to *G. tomentosa*. In addition, the narrowly oblong petaloid scales of *G. denudata* distinguish it from *G. tomentosa* which has broad fleshy scales.

The distribution of this species shows a clear disjunction (Figure 10). It occurs south of Oudtshoorn and in the Knysna District of Western Cape and in the Willowmore District of Eastern Cape, where it inhabits margins of afromontane forest (Lubke & McKenzie 1996). Additional, less precise, distribution records (omitted from Figure 10) come from Western and Eastern Cape, the Swellendam Mountains; near Touws River, and the forest at Elands River, Tsitsikamma, Humansdorp (Wright 1915). The population from Inhaca Island,

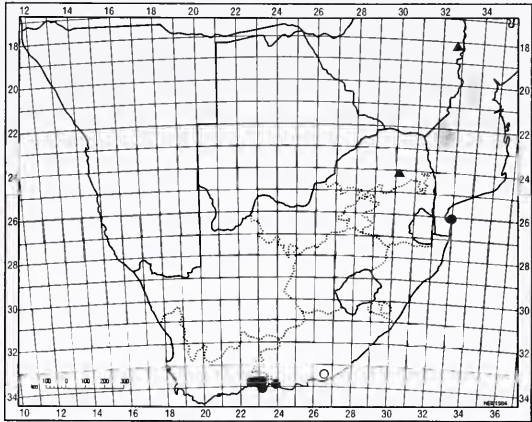


FIGURE 10.—Recorded distribution of *Gnidia denudata*, ●, (O disputed record); *Plectranthus dolomiticus*, ▲.

Mozambique, is highly disjunct. A specimen housed in the Geneva Herbarium and apparently collected by Drège from Port Natal (Durban) is probably erroneously labelled, as this species does not appear in any of his listing of collections from the province (Drège 1843). The specimen *Coetzee s.n.*, collected in KwaZulu-Natal (and without any further locality details) in 1943, appears to be the only other collection from this province, which is curious in the light of the common occurrence of Cape relicts on the Natal Group Sandstone of the eastern seaboard (Van Wyk 1990). The species also appears to be absent from the mainland of Mozambique. Wright (1915) regarded the specimen, *Rogers 20682* (STE), collected near Grahamstown, as a doubtful record, but in the light of the Inhaca population, this may warrant further investigation.

Specimens examined

WESTERN CAPE.—3322 (Oudtshoorn): Saasveld Forestry College, (–DC), Beaumont & Smith s.n. (NU); Karatura River, (–DD), Schlechter 5887 (C). 3323 (Willowmore): Diepwalle Forest Reserve, (–CC), Bos 735 (STE). 3423 (Knysna): between Kruisfontein and Bracken Hill, (–AA), Dahlgren & Peterson 1484 (GB).

EASTERN CAPE.—3323 (Willowmore): Camel Pile, (–DD), Esterhuysen 27327 (GB), 3326 (Grahamstown): Grahamstown, (–BC), Rogers 28682 (GRA).

KWAZULU-NATAL.—Precise locality unknown: *Coetzee s.n.* (J), *Drège s.n.* (G).

MOZAMBIQUE.—2632 (Bela Vista): Inhaca Island, (–BB), Maguire 35 (J).

LAMIACEAE

*Plectranthus dolomiticus* was described in 1984 by Codd. At that time, and in the subsequent FSA account (Codd 1985), the species was known only from the type locality near Penge Mine in Mpumalanga. Recently, a second population of the species was recorded from granite domes in Zimbabwe (Figure 10). While the geology of the respective sites is different, the physical aspects are very similar. Both populations occur in arid woodland on rock outcrops where plants occur in humus-filled crevices. During the dry season the species withers aerially and the populations rely on subter-



ranean tubers for sustenance. The disjunction, approaching 700 km, is considerable for *Plectranthus* species which have no mechanism to aid long-distance dispersal. It is therefore likely that additional populations of the species occur(ed) in the intervening rocky savanna. Codd's (1985) interpretation of alliances, between *P. dolomiticus* and the remainder of the genus, was that its closest relative is *P. petiolaris*. Considerable similarity exists between the flowers of these two species, both of which are sigmoid, with similar proportions and deep purple colouring. Recently a third species, which displays a very similar corolla, was discovered in Zimbabwe (Edwards, Paton & Crouch 2000). This last species, *P. porphyranthus* T.J. Edwards & N. Crouch, is without doubt convergent in corolla form for it belongs to section *Coleoides*, whereas the former species are members of section *Plectranthus*. The convergence is probably being driven by widespread anthophorid bees, of the genus *Amegilla*, which are the primary pollinators. *Amegilla caelestina* (Cockrell), *A. fallax* (Smith) and *A. bothai* (Meadt-Woldo) were recorded on *P. porphyranthus*, and *A. caelestina*, *A. bothai* and *A. mimad-vena* (Cockrell) are the primary pollinators of *P. petiolaris*. The proposed alliance of *P. dolomiticus* with *P. petiolaris* (Codd 1985), based on corolla characters, may need reviewing in light of the convergent corolla design of *P. porphyranthus*.

### Specimens examined

#### *Plectranthus dolomiticus*

ZIMBABWE.—1832 (Juliasdale), Pine Lake Inn, (–BA), Vos 339 (NU).

#### *Plectranthus porphyranthus*

ZIMBABWE.—2029 (Harare), Masvingo, (–BB) Richmond Farm, Crouch 800 (E, K, NH, NU, PRE); Harare, 3 miles [4.8 km] east of Zimbabwe (ruins), Leach 8043 (PRE).

### ACKNOWLEDGEMENTS

The Natal University Research Fund and the National Research Fund are thanked for their financial assistance. The following herbaria C, G, GB, GRA, J, K, NU, PRE and STE are thanked for the loan of herbarium material and the National Botanical Institute, Pretoria, is thanked for access to the Mary Gunn Library. Neil Crouch is acknowledged for his endless enthusiasm in tracking down obscure references. Christina Potgieter is thanked for contributing insect data on the pollination of *Plectranthus petiolaris*. Rod Edwards is acknowledged for his contribution in the discovery of the *Metarungia pubinervia* population.

### REFERENCES

AGNEW, A.D.Q. 1974. Acanthaceae. *Upland Kenya wild flowers*: 573–611. Oxford University Press.

- ANDERSON, T. 1863. African Acanthaceae. *Proceedings of the Linnaean Society, Botany* 7: 13–54.
- BADEN, C. 1981. The genus *Macrorungia* (Acanthaceae), a taxonomic revision. *Nordic Journal of Botany* 1: 638.
- BADEN, C. 1984. *Metarungia*, a valid name for *Macrorungia* auctt. (Acanthaceae). *Kew Bulletin* 39: 638.
- BRENAN, J.P.M. & GREENWAY, P.J. 1949. *Checklist of the forest trees and shrubs of the British Empire, Tanganyika Territory* 5.2: 1–319. Imperial Forestry Institute, Oxford.
- CLARKE, C.B. 1900. Acanthaceae. *Flora of tropical Africa* 5: 1–255. Reeve, London.
- CODD, L.E. 1984. A new species of *Plectranthus* (Lamiaceae). *Bothalia* 15: 142, 143.
- CODD, L.E. 1985. *Plectranthus* (Lamiaceae). *Flora of southern Africa* 28.4: 137–172.
- DALE, I.R. & GREENWAY, P.J. 1961. *Kenya trees and shrubs*. Hatchards, London.
- DRÈGE, J.F. 1843. Zwei pflanzengeographische Documente. *Flora* 2: 44–229. Leipzig/Regensburg.
- EDWARDS, T.J. & HARRISON, E.R. 1998. New records from KwaZulu-Natal, South Africa. *Bothalia* 28: 187–190.
- EDWARDS, T.J., PATON, A. & CROUCH, N. 2000. A new species of *Plectranthus* (Lamiaceae) from Zimbabwe. *Kew Bulletin* 55: 459–464.
- HEINE, H. 1966. Acanthaceae. *Flora du Gabon* 13: 3–241. Paris.
- HOOKE, J.D. 1827. *Gnidia tomentosa*. *Botanical Magazine* 54: t. 2761. London.
- LINDAU, G. 1894. Acanthaceae africanae II. *Botanische Jahrbücher* 20: 1–78.
- LINDAU, G. 1895a. Acanthaceae. *Die Pflanzenwelt Ost-Afrikas und der Nachbargebiete Deutsch Ost-Afrika* 5.C: 365–374.
- LINDAU, G. 1895b. Acanthaceae. *Die natürlichen Pflanzenfamilien* 4.3b: 274–354. Leipzig.
- LINDLEY, J. 1823. *Gnidia denudata*. *Botanical Register* 9: t. 757. London.
- LINNAEUS, C. 1753. *Gnidia tomentosa*. *Species plantarum*, edn 1. Salvius, Stockholm.
- LUBKE, R. & MCKENZIE, B. 1996. In A.B. LOW & A.G. REBELO, *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.
- MEISNER, C.F. 1840. Synopsis Thymelaeacearum, Polygonearum et Begoniarum Africae Australis, imprimis a cl. J.J. Drège lectarum. *Linnaea* 14: 385–516.
- MEISNER, C.F. 1857. Thymelaeaceae. In A.P.D. de Candolle, *Prodromus systematis naturalis regni vegetabilis* 14: 493–605. Treuttel & Würtz, Paris, Strasbourg, London.
- SPRENGEL, K. 1827. In C. Linnaei, *Systema vegetabilium, Curae posteriores* 152. Göttingen.
- VAN WYK, A.E. 1990. The sandstone regions of Natal and Pondoland: remarkable centres of endemism. *Palaeoecology of Africa and the surrounding islands* 21: 243–257. Balkema, Rotterdam.
- WRIGHT, C.H. 1915. Thymelaeaceae. In W.T. Thistelton-Dyer, *Flora capensis* 5.2: 63, 64. Reeve, Ashford, Kent.

T.J. EDWARDS\*†, A.J. BEAUMONT\* and D. STYLES\*

\* School of Botany and Zoology, University of Natal, Private Bag X01, 3209, Scottsville.

† Author for correspondence.

MS. received: 2000-10-26.

## COLCHICACEAE

A REMARKABLE NEW SPECIES OF *ANDROCymbium* FROM NORTHERN CAPE, SOUTH AFRICA

## INTRODUCTION

A member of the Old World liliacean family Colchicaceae (Nordenstam 1998), *Androcymbium* Willd. is a largely African genus comprising some 40 species, mainly of arid and semi-arid areas. It has its greatest diversity in southern Africa where the majority of species, at least three quarters of the total, occur (Muller-Doblies 1984; Meyer 2000). Just three of these extend into tropical Africa, one as far north as Ethiopia (Baker 1897; Sebsebe Demissew 1997). Two more species are endemic to the Canary Islands and a further six are distributed along the arid fringe of the south Mediterranean littoral (Pedrola-Monfort & Caujapé-Castells 1998). The genus is distinguished from the other truly cormous members of the family by its condensed or rarely elongated stem, and stellate-campanulate flowers with free tepals borne in the axils of large, leaf-like bracts.

The genus *Androcymbium* was divided by Krause (1921) into three sections based on the shape of the tepals. The largest of these sections, sect. *Androcymbium* (= *Cymbanthies*) is characterized by auriculate, deeply cucullate tepal limbs and is almost entirely southern African with a few species extending into tropical Africa, Ethiopia and Eritrea. The remaining sub-Saharan species, along with the more northern members of the genus, have flat or shallowly concave tepal limbs without distinct basal auricles. Relationships between these species are difficult to infer. Krause (1921) recognized the somewhat heterogeneous nature of the group in erecting the monotypic sect. *Dregeocymbium* to accommodate the rather aberrant southern African *A. dregei* Presl. This species is distinguished from the other taxa with plane tepals by its well-developed aerial stem and extremely short stylules. The other species with flat tepals known to him, which included the Mediterranean taxa plus two of the sub-Saharan species, *A. bellum* Schltr. & Krause and *A. roseum* Engl., were accommodated in sect. *Erythroctictus*.

The distinction between sections *Dregeocymbium* and *Erythroctictus* was blurred by the subsequent discovery of two species from southern Namibia and northern Namaqualand, *A. exiguum* Roessler and *A. cruciatum* U. & D. Müll.-Doblies, which are apparently intermediate between them (Roessler 1974; Müller-Doblies & Müller-Doblies 1984). The two sections were consequently combined by Müller-Doblies & Müller-Doblies (1984). Section *Erythroctictus* thus currently comprises four species from southern Africa and about six species from the Canary Islands and the Mediterranean. Among the southern African species of sect. *Erythroctictus*, three are restricted to the winter rainfall region of Western and Northern Cape and southern Namibia, and only one, *A. roseum*, was previously known to occur in the summer rainfall zone of southern Africa. This unusual species occurs in northern Namibia, Angola and Botswana. It is readily distinguished from all other southern African species by its rosulate, multifoliate habit and prominent-

ly exposed pinkish flowers that are not concealed by the leaf-like bracts. It was a great surprise, therefore, to encounter a similar species in the Great Karoo near De Aar. Closer examination revealed that although allied to *A. roseum*, it is quite distinct from that species.

***Androcymbium asteroides* J.C. Manning & Goldblatt**, sp. nov., haec species habitu caulescente, foliis rosulatis multis atque tepalorum limbis oblongis exauriculatis *Androcymbio roseo* Engl. similis, sed ab eo foliis lanceolatis (3–)10–18 mm latis atque floribus omnino albis supra apicem plantae vix vel haud protuberantibus tepalorum breviorum latiorumque ungue  $\pm 7 \times 3$  mm ac limbo ovato 8–9  $\times$  4–6 mm differt.

TYPE.—Northern Cape, 2922 (Prieska): Prieska commonage, in vlei ground, 06-05-1928, (–DA), *Bryant sub Marloth 13570* (PRE, holo.).

Stemless perennial with indistinguishable internodes and leaves in basal rosette. *Corn* ovoid, 10–15 mm diam.; tunics dark brown, coriaceous. *Cataphyll* single, 70–110 mm long, translucent, papery in texture. *Leaves*  $\pm 8$ , spreading, lanceolate, (60–)90–110  $\times$  (3–)10–18 mm, but expanding up to 25 mm wide at base, attenuate, amplexicaul, upper leaves widening more conspicuously towards base than lower, spirally inserted, glaucous green, lightly canaliculate with depressed median vein, margins ciliolate, grading into floral leaves; fertile floral leaves shorter and broader at base than foliage leaves, partially encircling flowers but not obscuring them, suberect or incurved. *Flowers* 2–6, sessile, not or slightly protruding above crown of plant; perianth  $\pm 10$  mm diam., white, unscented; tepals unequal, inner slightly smaller than outer, (13–)15–17 mm long, limb flat or lightly concave, ovate, 8–9  $\times$  4–6 mm, claw oblong-cuneate, 6–8  $\times$  2–3 mm. *Stamens* included; filaments arcuate, 4–5 mm long, greenish yellow; anthers 2 mm long, yellow; nectary wider than filament base, ovate with central keel, 1.2 mm diam., greenish yellow. *Ovary* obovoid, 3-lobed, 5–6 mm long, white flushed green above, stylules 6 mm long, white, stigmas elongate, 1 mm long. *Capsule* subglobose, coriaceous, 17 mm long. *Seeds* subglobose, 2.0–2.5 mm diam., dark brown, testa rugulose. *Flowering time*: May to June. Figure 11.

**Distribution and biology:** the species is largely restricted to the southern edge of the interior plateau of southern Africa at altitudes of  $\pm 1\,400$  m (Figure 12), and is not uncommon southeast of De Aar around Hanover and Richmond in Northern Cape. It occurs in seasonally waterlogged depressions in clay soils, usually derived from dolerite. These depressions, due to the particular properties of the doleritic clays, are locally moist for much longer than the surrounding flats and constitute a specialized, highly localized habitat that is occupied by several dwarf geophytes apart from *Androcymbium asteroides*. Among these are *Massonia comata*, *Polyxena ensifolia* (Hyacinthaceae) and *Moraea falcifolia* (Iridaceae). These





FIGURE 11.—*Androcymbium asteroides*. A, whole plant with corm; B, individual flower and subtending leaf; C, outer tepal and stamen; D, gynoecium. Scale bars: 10 mm. Artist: John Manning.

plants share a suite of morphological characters, including the stemless habit with spreading or prostrate leaves, subterranean ovaries and pale-coloured flowers apparently adapted to a generalist pollination strategy. Their growth cycle is closely linked to the local climate and they sprout rapidly in response to the late summer and autumn rains that characterize the climate of the area. They flower soon after sprouting, in late autumn or early winter, before temperatures drop too low for active growth.

**History:** this singular species seems to have been first collected by E.G. Bryant in 1925. Bryant, a mining engineer with a great interest in fodder plants and conservation, moved to Prieska in 1920, where he collected extensively. This first collection was sent to the Bolus Herbarium, where it remained among the *incertae*.

Bryant was clearly intrigued by the species as he made several collections of it over the years. The second of these, which serves as the type, he sent to Rudolf Marloth, who identified it as *A. roseum*. This determination was then applied to the few subsequent collections that have been made.

**Diagnosis and relationships:** *Androcymbium asteroides* is clearly allied to *A. roseum*, with which it shares a multifoliate, rosette habit and more or less flat or shallowly concave tepal limbs lacking prominent basal auricles. It is distinguished from *A. roseum* by the broader, lanceolate leaves with the blades usually at least 10 mm wide towards the base and smaller, pure white flowers that do not protrude much above the crown of the plant. The tepal claws are oblong, 6–8 mm long and the limbs ovate, 8–9 × 4–6 mm. *A. roseum* is characterized by linear-lanceolate leaves up to 5 mm wide and pinkish or pink-streaked flowers that protrude conspicuously above the crown of the plant. The tepal claws are narrowly oblong, 10–12 mm long and the narrowly oblong-elliptic limbs are 13–16 × 3–4 mm. A fine illustration of *A. roseum* accompanies the account of the species by Dyer (1956).

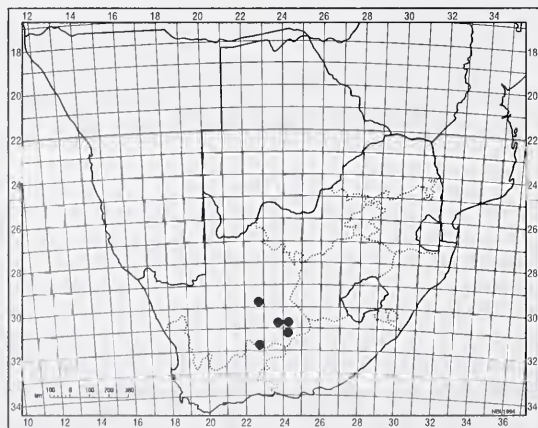


FIGURE 12.—Distribution of *Androcymbium asteroides* in Northern Cape.

These two species show a marked similarity to the Mediterranean species of *Androcymbium* in their multifoliate, rosette habit, monomorphic leaves and flat tepals. It is likely, however, that most if not all of these are plesiomorphic states and the exact relationship between the Mediterranean and Macronesian species and the other African members of sect. *Erythrostictus* has yet to be demonstrated. A resolution of the broad patterns of relationships between the species of *Androcymbium*, especially those of section *Erythrostictus*, is an essential prerequisite to understanding the historical biogeography of the genus.



## Additional material examined

NORTHERN CAPE.—2922 (Prieska): Prieska, 05-1925, (–DA), *Bryant s.n.* (BOL); Prieska, 10-1928, *Bryant s.n.* (PRE); Prieska, 07-35, *Bryant 1128* (PRE). 3023 (Britstown): De Aar, Quaggafontein, sandy karoo in open patches, 06-05-1946, (–DB), *Acocis 12604* (PRE). 3122 (Loxton): Meltonwold, northwest of Graskop, dry vle, 13-05-1976, (–DB), *Thompson 3065* (PRE). 3123 (Victoria West): Richmond, 3 km SE of town along road to Graaff-Reinet, seasonally waterlogged drainage line in dolerite, 28-04-2001, (–BD), *Manning 2322* (NBG); 27-05-2001, *Snijman 1815* (NBG).

## ACKNOWLEDGEMENTS

Our thanks to C. Archer (PRE) and T. Trinder-Smith (BOL) for expediting the loan of material from their respective herbaria, B. Momberg, and the referees for their efficiency, Roy Gereau for his incomparable Latin diagnosis, and Dee Snijman for kindly collecting further material. Material for study was collected on a permit provided by Northern Cape Department of Nature and Environmental Conservation.

## REFERENCES

BAKER, J.G. 1897. Liliaceae. *Flora of tropical Africa* 7: 559, 560.  
DYER, R.A. 1956. *Androcymbium roseum*. *The Flowering Plants of Africa* 31: t. 1225.

KRAUSE, K. 1921. Revision der Gattung *Androcymbium* Willd. *Notizblatt des Botanischen Gartens und Museums zu Berlin-Dahlem* 70: 512–526.  
MEYER, N. L. 2000. Colchicaceae. In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10.  
MÜLLER-DOBLIES, U. & MÜLLER-DOBLIES, D. 1984. Zur Kenntnis der Gattung *Androcymbium* (Colchicaceae) im südlichen Afrika: Zwei Synonyma und fünf neue Arten. *Willdenowia* 14: 179–197.  
NORDENSTAM, B. 1998. Colchicaceae. In K. Kubitzki, *The families and genera of vascular plants* III Liliaceae (except Orchidaceae). Springer-Verlag, Berlin.  
PEDROLA-MONFORT, J. & CAUJAPÉ-CASTELLS, J. 1998. The *Androcymbium* species of the Canary Islands. *Curtis's Botanical Magazine* 15: 67–77.  
ROESSLER, H. 1974. Die Gattung *Androcymbium* Willd. (Liliaceae) in Südwestafrika. *Mitteilungen der Botanischen Staatssammlung, München* 11: 545–566.  
SEBEBE DEMISSEW, S. 1997. Colchicaceae. *Flora of Ethiopia and Eritrea* 6: 184–189.

J.C. MANNING\* and P. GOLDBLATT\*\*

\* Compton Herbarium, National Botanical Institute, Private Bag X7, Claremont 7735, Cape Town, South Africa.

\*\* B.A. Krukoff Curator of African Botany, Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri 63166, USA.

## PTERIDOPHYTA

## NEW DISTRIBUTION RECORDS OF SOUTHERN AFRICAN PTERIDOPHYTA

Recent travels by the authors have resulted in the collection of a number of new national and provincial records of pteridophytes from the southern African sub-region which are not reflected in the most recent revisions and regional checklists. The Malawian records update Burrows & Burrows (1993); the South African records update Burrows (1990) and Roux (1995), while the Zambian records update Kornas (1979). All specimens are housed in the Buffelskloof Herbarium, Lydenburg, South Africa; duplicates, where distributed, are indicated.

## MALAWI

**Anogramma leptophylla** (L.) Link, Filicum species in horto regio botanico berolinensis cultae: 137 (1841); Schelpe: 99, t. 32 (1970); J.E.Burrows: 114, t. 26 (1990). Type: South Europe, *Tournefort 5337* (P, lecto.).

MALAWI.—1033: (North), Nyika National Park, S slopes of Nganda Hill, 2 480 m, (–BD), 31 March 2000, J.E. & S.M. Burrows 6850 (Buffelskloof Herb., MAL, NBG, SRGH, UZL).

This very small, ± 10 mm tall annual fern, frequently mistaken for sporelings of other ferns, was found growing in the lee of large boulders in montane grassland. It is fairly widespread in Africa although, due to its extremely small size, it is frequently overlooked. It has been collected in South Africa and Zimbabwe to the south, and northwards in Tanzania and Kenya.

**Asplenium erectum** Bory ex Willd. in Species plantarum edn 5: 328 (1810); N.C. Anthony & Schelpe: 190 (1986); J.E.Burrows: 223, t. 51 (1990). Type: Réunion, *Bory s.n.* (B-W19906, lecto.).

var. **erectum**.

MALAWI.—1033: (North), Nyika National Park, Zovochipolo Forest, 2 200 m, (–DA), 2 April 2000, J.E. & S.M. Burrows 6893 (Buffelskloof Herb.).

This specimen was found growing near a small stream in the deep shade of evergreen montane forest. In addition to being a new record for Malawi, it is significant that, in Africa, this variety was only previously known from South Africa. It is not known from Zimbabwe or southern Malawi and therefore represents an unusually disjunct record into tropical Africa.

**Cyathea mossambicensis** Baker in Annals of Botany 5: 185 (1891); Schelpe: 72 (1970); J.E.Burrows: 86, t. 18 (1990). Type: Mozambique, Namuli, *Last s.n.* (K, holo.).

MALAWI.—1134: (North), Mzuzu, ± 15 km from Mzuzu on the Nkhata Bay road, (–CA), 14 May 1999, J.E. Burrows 6484 (Buffelskloof Herb.).

Plants were found growing in dense riverine forest along a small stream, near the summit of the western

escarpment of the Lake Malawi rift above Nkhata Bay, an area of unusually high rainfall in Malawi (Chapman & White 1970). This is the first record of this taxon from Malawi; elsewhere *C. mossambicensis* occurs in eastern Zimbabwe, Mozambique and Tanzania.

**Ophioglossum convexum** *J.E. Burrows* in *Bothalia* 19: 167, t. 1 (1989). Type: South Africa, Mpumalanga, Lydenburg Dist., Coromandel Farm, *J.E. Burrows* 3683 (PRE, holo.!, BOL!, K!).

MALAWI.—1033: (North), Nyika National Park, Wowve River, 2 030 m. (–BD), 4 Apr. 2000, *J.E. & S.M. Burrows* 6909 (Buffelskloof Herb., MAL, PRE, UZL).

This very small fern (trophophore 10–13 mm long) is distinguished by its small suborbicular trophophores which are held ± appressed to the ground. It was found growing in montane grassland on alluvial soils near a river, growing in association with *O. lusoafricanum* Welw. ex Prantl. It is currently known from South Africa and Zimbabwe and this record therefore extends its known distribution well into tropical Africa.

#### SOUTH AFRICA

**Thelypteris dentata** (*Forssk.*) *E.P. St. John* var. *buchananii* *Schelpé* in *Journal of South African Botany* 31: 265 (1965), excl. *Buchanan* 8 [vide *Holtum*: 142 (1974)]; *Schelpé*: 198 (1970); *J.E. Burrows*: 264 (1990). Type: Mozambique, Manica e Sofala, Garuso, 'Jaegersberg' (Bandula Mt), *Schelpé* 5599 (BOL, holo.!).

KWAZULU-NATAL.—2831 (Nkandla): Ongoye Forest, (–DC), 18 Feb. 1996, *J.E. & S.M. Burrows* 5944 (Buffelskloof Herb.).

Plants were found growing on a deeply shaded forest floor in evergreen forest. Previously this variety was only known from Zimbabwe, Mozambique and Malawi. Var. *buchananii* is distinguished from the typical variety by having two or more pairs of veins anastomosing below the sinus between the ultimate pinna lobes (compared to 1½ pairs, or 3 veins, in var. *dentata*).

**Thelypteris hispida** (*Decne.*) *C.F. Reed* in *Phytologia* 17: 283 (1968); *J.E. Burrows*: 264, t. 64 (1990); *J.E. Burrows & S.M. Burrows*: 95 (1993). *Christella hispida* (*Decne.*) *Holtum*: 312 (1976). Type: Indonesia, Timor, *Guichenot* s.n. (P, holo.).

*Thelypteris quadrangularis* (*Fée*) *Schelpé*: 196 (1964); *Schelpé*: 266 (1965); *Schelpé*: 195 (1970). Type: Guyana, *Leprieux* 182 (P, ?holo.; NY).

*Christella hilsenbergii* (*C. Presl*) *Holtum*: 142 (1974). *Thelypteris hilsenbergii* (*C. Presl*) *Panigrahi*: 369 (1975). Type: Mauritius, *Sieber* s.n. (PRC, holo.; K, P).

KWAZULU-NATAL.—2831 (Nkandla): Ongoye Forest, (–DC), 18 Feb. 1996, *J.E. & S.M. Burrows* 5932 (Buffelskloof Herb.).

Growing in evergreen forest, in deeply shaded sites along a stream. This is the first record of *T. hispida* from South Africa; previously this species had been recorded as far south as Chirinda Forest in southeastern Zimbabwe.

**Polypodium vulgare** *L.*, *Species plantarum* 2: 1085 (1753); *Schelpé & N.C. Anthony*: 157 (1986); *J.E. Burrows*: 193, t. 195 (1990). Type: Europe (not found).

MPUMALANGA.—2530 (Lydenburg): Lydenburg Dist., Mokobulaan Plantations, (–BA), 2 100 m, 26 Feb. 2000, *J.E. Burrows, A. & J. Nel* 6716 (Buffelskloof Herb., J, NBG, PRE).

*Polypodium vulgare* is widespread throughout the temperate zone of the northern hemisphere. Somewhat anomalously it also occurs on the South Atlantic island of Kerguelen, and in temperate South Africa, extending from the mountains of the Western Cape to the high Drakensberg Mountains of KwaZulu-Natal (*Schelpé & Anthony* 1986). This new record extends the distribution of the species northwards well beyond its current range.

**Polystichum wilsonii** *H. Christ* in *Botanical Gazette* 51: 353 (1911); *J.P. Roux*: 149, t. 51 (1998). Type: China, Szechuan Province, Mupin, *Wilson* 2614 (BM, holo.).

*Polystichum alticola* *Schelpé & N.C. Anthony* in *Anthony & Schelpé*: 144 (1982); *Schelpé & N.C. Anthony*: 257 (1986); *J.E. Burrows*: 317 (1990). Type: South Africa, Western Cape, Ladismith, Swartberg, Towerkop, *Esterhuysen* 26699 (BOL, holo.; C, G, GH, K, M, MO, NBG, P, PRE).

MPUMALANGA.—2530 (Lydenburg): Lydenburg Dist., Mokobulaan Plantations, (–BA), 2 100 m, 26 Feb. 2000, *J.E. Burrows, A. & J. Nel* 6717 (Buffelskloof Herb., NBG).

This species occurs from the southern Cape mountains through the mountains of the Drakensberg to the Wakkerstroom area. Further north, *P. wilsonii* is represented in Zimbabwe by three collections. It then 'jumps' to northern Tanzania, Kenya, Ethiopia and westwards to Cameroon and Bioko (*Roux* 1998). It is found also through much of eastern Asia as far as China. The above collection serves to close the perceived gap in its distribution between the Drakensberg Mountains of South Africa and the Eastern Highlands of Zimbabwe.

#### ZAMBIA

**Mohria marginalis** (*Savigny*) *J.P. Roux* in *South African Journal of Botany* 56: 401 (1990). Type: Réunion ('Bourbon'), *Commerson* s.n. (P, lecto.).

*Mohria hirsuta* *J.P. Roux*: 435 (1984). Type: South Africa, Free State, Qwa Qwa, Tsheseng, near cave on road to The Sentinel, *Roux* 907 (NBG, holo.; K, PRE).

ZAMBIA.—1124: North-Western Province, Luakela River, on road from Mwinilunga to Ikalenge, (–CB), 4 March 1999, *J.E. & S.M. Burrows* 6433 (Buffelskloof Herb., NBG).

Plants were found growing in miombo (*Brachystegia–Julbernardia–Isobornia*) woodland near a river, on a rocky outcrop in light shade. This is 1210he first record of this species from Zambia and the first record of any species of *Mohria* from the western half of Zambia (*Kornas* 1979). The woodland habitat of this collection is anomalous for this taxon which is otherwise a montane species (*Roux* 1995).

**Ophioglossum ammophilum** *C.D. Adams* in *Annals and Magazine of Natural History*, ser. 12, 7: 874 (1954). Type: Nigeria, Accra Dist., near Labadi, near Kapesi Lagoon, *Adams* GC4642 (BM, holo.!, K!).

ZAMBIA.—0932: Northern Province, 52 km from Nakonde on the Mbala road, (–AB), 14 Feb. 1995, *J.E. & S.M. Burrows* 5796 (Buffelskloof Herb., K).

Plants were found growing on the outer margins of a shallow seasonally inundated pan over laterite, in miombo woodland, in association with *Ophioglossum costatum* R.Br., *O. luso-africanum* Welw. ex Prantl, *O. thomasi* R.T.Clausen and *O. vulgatum* L. subsp. *africanum* Pocock ex J.E.Burrows var. *africanum*. This is the first record of this species for the southern African subregion; previously it was known only from Nigeria, Sudan and Ethiopia. *Ophioglossum ammophilum* is very similar to *O. gomezianum* Welw. ex A.Braun but is distinguished from that species in the field by its somewhat orange tinge to the sporophore and the few pale basal-medial cells on the tropophore, creating the impression of a pseudo-midrib.

ACKNOWLEDGEMENTS

The Fern Society of South Africa, particularly Allan and Jolanda Nel, is acknowledged for their part in the discovery of the two new Mpumalanga records; the Parker and Engelbrecht families for access to Mokobulaan; and J.P. (Koos) Roux for confirming the identification of *Mohria marginalis*. The Southern African Botanical Diversity Network (SABONET) is thanked for providing the opportunity to visit northern Malawi.

REFERENCES

ADAMS, C.D. 1954. New species of ferns from the Gold Coast. *Annals and Magazine of Natural History*, ser.12, 7: 874.  
ANTHONY, N.C. & SCHELPE, E.A.C.L.E. 1982. New species and new combinations in African Pteridophyta and Orchidaceae. *Contributions from the Bolus Herbarium* No.10: 143–164.  
BAKER, J.G. 1891. A summary of the new ferns which have been discovered or described since 1874. *Annals of Botany* 5: 185.  
BURROWS, J.E. 1989. New taxa, combinations and records of Pteridophyta from southern and central Africa. *Bothalia* 19: 167–174.  
BURROWS, J.E. 1990. *Southern African ferns and fern allies*. Frandsen Publishers, Sandton.

BURROWS, J.E. & BURROWS, S.M. 1993. An annotated checklist of the pteridophytes of Malawi. *Kirkia* 14: 78–99.  
CHAPMAN, J.D. & WHITE, F. 1970. *The evergreen forests of Malawi*. Commonwealth Forestry Institute, University of Oxford.  
CHRIST, K.H.H. 1911. Filices wilsonianae. *Botanical Gazette* 51: 345–359.  
HOLTUM, R.E. 1974. Thelypteridaceae of Africa and adjacent islands. *Journal of South African Botany* 40: 123–168.  
HOLTUM, R.E. 1976. The genus *Christella* Léveillé, sect. *Christella*. Studies in the family Thelypteridaceae, XI. *Kew Bulletin* 31: 293–339.  
KORNAS, J. 1979. *Distribution and ecology of the pteridophytes in Zambia*. Państwowe Wydawnictwo Naukowe, Kraków.  
LINK, J.H.F. 1841. *Filicum species in horto regio botanico berolinensis cultae*. Berolini.  
LINNAEUS, C. 1753. *Species plantarum* 2, edn 1. Holmiae.  
PANIGRAHI, G. 1975. Notes on certain taxa of *Thelypteris* (Thelypteridaceae) of Asia, II. *Phytologia* 31: 369–372.  
REED, C.F. 1968. Index thelypteridis. *Phytologia* 17: 249–466.  
ROUX, J.P. 1984. *Mohria lirsuta*, a new fern species from the Drakensberg. *Journal of South African Botany* 50: 435–441.  
ROUX, J.P. 1990. A new species and combination in *Mohria* (Schizaeaceae: Pteridophyta). *South African Journal of Botany* 56: 399–402.  
ROUX, J.P. 1995. Systematic studies in the genus *Mohria* (Pteridophyta: Anemiaceae). VI. Taxonomic review. *Bothalia* 25: 1–12.  
ROUX, J.P. 1998. *A taxonomic revision of Polystichum (Pteropsida: Dryopteridaceae) in Africa and neighbouring islands*. Ph.D. thesis, University of Pretoria, Pretoria.  
SCHELPE, E.A.C.L.E. 1964. Pteridophyta collected on an expedition to northern Mozambique. *Journal of South African Botany* 30: 177–200.  
SCHELPE, E.A.C.L.E. 1965. A review of the southern African species of *Thelypteris*. *Journal of South African Botany* 31: 259–269.  
SCHELPE, E.A.C.L.E. 1970. Pteridophyta. In A.W. Exell & E. Launert, *Flora zambesiaca*. Crown Agents, London.  
SCHELPE, E.A.C.L.E. & ANTHONY, N.C. 1986. Pteridophyta. *Flora of southern Africa*. Botanical Research Institute, Pretoria.  
WILLDENOW, C.L. 1810. In Caroli a Linné, *Species plantarum* edn 5. Berolini.

J.E. BURROWS\* and S.M. BURROWS\*

\* Buffelskloof Herbarium, P.O. Box 710, 1120 Lydenburg, South Africa. MS. received: 2000-09-26.

GENTIANACEAE

A NEW SPECIES OF *SEBAEA* FROM THE SWARTBERG RANGE, WESTERN CAPE, SOUTH AFRICA

***Sebaea amicornum* I.M.Oliv. & Beyers**, sp. nov., in genere distincta foliis lanceolatis, floribus 4-meris, calyce minute carinata, antheris glande apicali minutissima, stylo sine tumore stigmatico dignoscenda. Figura 13.

TYPE.—Western Cape, 3322 (Oudtshoorn): Oudtshoorn, Groot Swartberg, neck just SE of Witberg on Angeliers Berg 187, 1 710 m, (–AC), 18 October 2000, E.G.H. & I.M.Oliver 11716 (NBG, holo.; K).

Delicate herbaceous biennial, or perennial (?), varying from small, ± 50 mm tall and 2–4-branched to 100–200 mm tall and many branched, main stem 10–150 × ± 2 mm. *Branches*: few to many, thin, delicate, erect, long main and secondary branches all glabrous with 2–4 longitudinal ridges, internodes 4–10 mm long. *Leaves* well developed, scattered along stem, opposite, spread-

ing, basal ones often reflexed, sessile, narrowly lanceolate, 5–12 × 1–2 mm, acute, flat, glabrous, midrib slightly prominent on abaxial surface only, margins microscopically dentate or entire. *Inflorescence* 1-flowered or a lax dichasium of 1st and 2nd order, sometimes 3rd order, at ends of all branches; 1st order peduncle 10–30 mm long, 2nd order peduncles 5–25 mm long, 3rd order peduncles 5–10 mm long; flowers 4-merous, ± 13 mm long, yellow; bracts subtending flower subspreading ± 3.5–5.0 × 1.0 mm, leaf-like; pedicel very short, ± 0.5 mm long. *Calyx* 4-partite, free, adpressed to corolla, segments elliptic to ovate, ± 7.0 × 2.6–3.5 mm, acute, veins not visible, slightly keeled abaxially, keel 0.2–0.3 mm broad, green centrally, becoming hyaline towards margins, glabrous, margins entire. *Corolla* 4-lobed; tube ± 4 mm long, shorter than lobes; lobes elliptic to ovate, 8.0–9.0 × 4.5 mm, subacute. *Stamens* 4, inserted in corol-



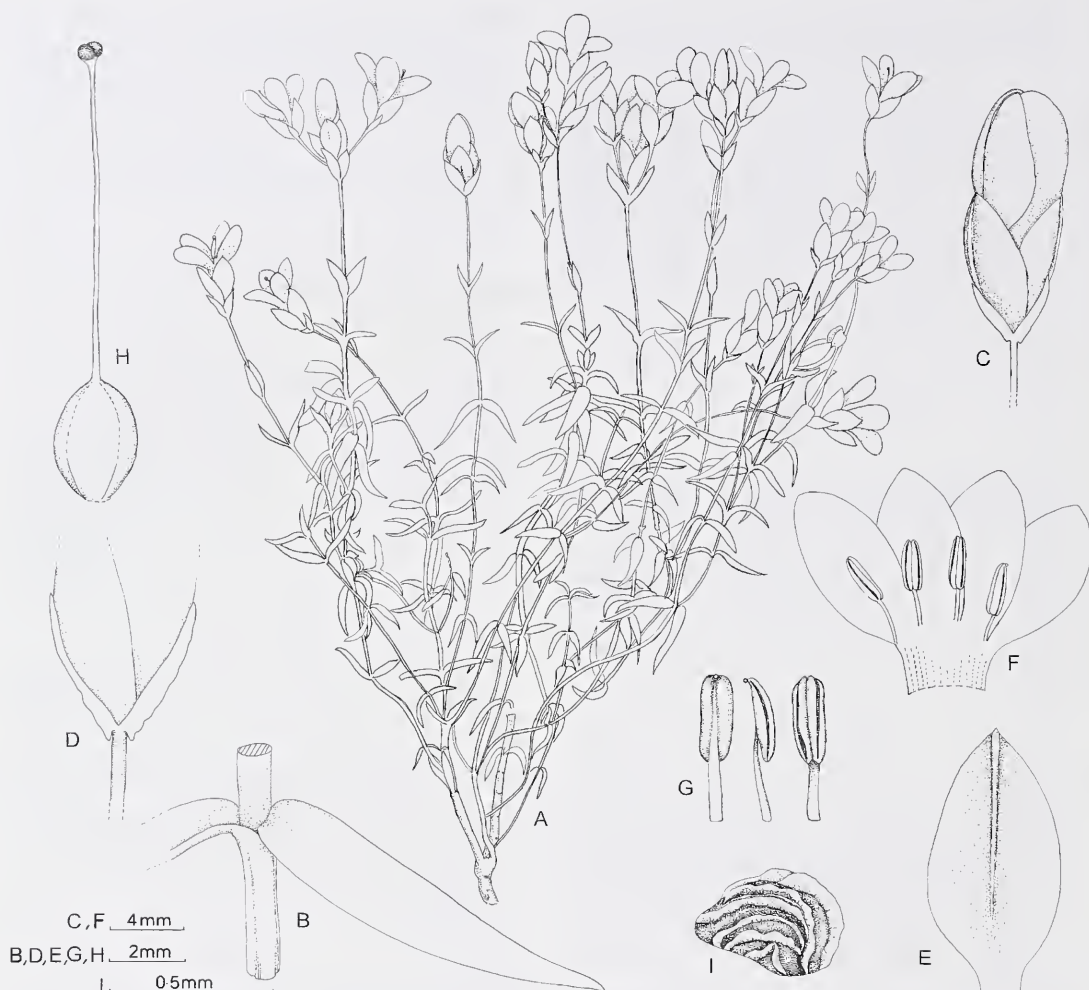


FIGURE 13.—*Sebaea amicorum*. A, flowering branch; B, stem with leaves; C, closed flower; D, bracts; E, sepal; F, corolla, opened and viewed adaxially; G, stamen, back, side and front views; H, gynoecium; I, seed. All drawn from the type collection. Scale bars: B, D, E, G, H, 2 mm; C, F, 4 mm; I, 0.5 mm. Artist: I.M. Oliver.

la sinuses; filaments  $\pm 1.5$  mm long; anthers  $\pm 2.4$  mm long, apex slightly recurved with very small sessile round apical gland, basal glands absent, thecae fully adnate. Ovary 2-locular, ellipsoid,  $2.5\text{--}4.0 \times 1.2\text{--}2.5$  mm, glabrous, with numerous ovules; style 6.2–8.5 mm long, filiform, with no stigmatic swelling; stigma capitate,  $\pm 0.4 \times 0.5$  mm, 2-lobed. Seeds  $\pm$  ovoid,  $\pm 0.4 \times 0.2$  mm, with many frilly small wings. Flowering time: October to December. Figure 13.

This new species is at first glance very distinct from all others in the genus mainly due to its leaves which are narrowly lanceolate and evenly distributed on the branches and to the large flowers. It is related to *S. capitata* Cham. & Schldl. and *S. laxa* N.E.Br. which also have 4-merous flowers.

*Sebaea capitata* is a more robust plant with thicker stems and with a different leaf shape—elliptic-ovate or ovate, cordate, 3–14 mm broad, with a distinct petiole, whereas *S. amicorum* has narrowly lanceolate leaves 1–2

mm broad, which are sessile. The sepals of *S. capitata* have a keel which is  $\pm 1.2$  mm broad compared to the very narrow keel,  $\pm 0.2\text{--}0.3$  mm broad, in the new species. *S. capitata* has inflorescences which are dense and compact with short peduncles, whereas *E. amicorum* has a loose open inflorescence. The anthers are similar in both species in that they have a minute apical gland, but the new species has much longer thecae—2.4 mm compared to 1.5 mm long. *S. capitata* has a style without or rarely with a stigmatic swelling and in *S. amicorum* there is no swelling.

Well-developed plants of *S. laxa* appear very similar to those of *E. amicorum* in that they are delicate and somewhat bushy, with similar lax secondary branching and with the inflorescences having similar secondary branching. However, the leaves of *S. laxa* are ovate, 2–6 mm broad, 1–3-nerved abaxially, even though they are similarly scattered over the whole plant. The flowers of *S. laxa* are much shorter and more delicate. Both species have an equally narrow keel down the sepals. Major dif-

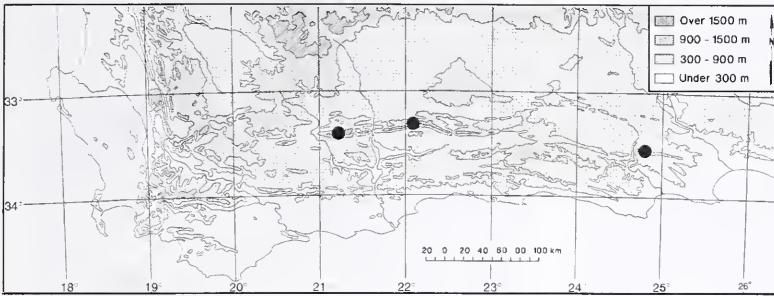


FIGURE 14.—Known distribution of *Sebaea amicornum*.

ferences between the two species occur in the anthers with *S. laxa* having short thecae 1.0–1.2 mm long, the apex much recurved with a large apical gland hanging on a short thread-like stalk. There is also a stigmatic swelling on the style in *S. laxa* which is absent in the new species.

Apart from one unnamed collection, *Esterhuysen 36120a*, from Towerkop [Toverkop] in the Klein Swartberg, which has 5-merous flowers and a large apical and basal gland on the thecae and ovate leaves, no other *Sebaea* species has been recorded from the very long Swartberg Mountain Range from near Ladismith to almost Willowmore. *S. amicornum* is represented by several collections from this Range but in two distinct areas—the Klein Swartberg above Ladismith and the region just east of the Swartberg Pass (Figure 14). Two of the peaks cited by Esterhuysen and Stokoe, Koudeveldberg (Koudeberg) and Krevasberg, cannot be located on any map.

In the *Flora of southern Africa*, Marais & Verdoorn (1963) cite under *S. capitata* var. *sclerosepala* (Schinz) Marais a collection, *Esterhuysen 28035*, from the Cockscomb in the Great Winterhoek Mtns. This was found to be clearly the same as the new species, but is far removed from the other two areas. This feature is not surprising in the genus *Sebaea* in which many species have very wide and disjunct distributions.

The species has been recorded by Esterhuysen from ledges, the base of cliffs and shady gullies mostly on the southern slopes of the Klein Swartberg at altitudes between 5500 and 6500 ft [1 670 and 1 980 m]. Linder

recorded 'shady, mossy S-facing ledges'. The type population was found on a moist stony S-facing slope just below the summit ridge in short grassy/restioid vegetation that had been burnt the previous year. The Cockscomb collection came from 'steep rocky SE slopes, marshy spot in gully'.

This new species is named *amicorum* = of the friends, because we have been closely involved as colleagues in the herbarium for the last 15 years.

#### Paratype material

WESTERN CAPE.—3321 (Ladismith): Klein Swartberg, Towerkop, 5500–6000 ft [1 670–1 830 m], (–AC), 16-12-1956, *Esterhuysen 26748* (BOL); ridge E of Towerkop, 2 000 m, (–AC), 7-02-1992, *Linder 5518* (PRE, photocopy); E. of Towerkop facing Elandsberg, 6000–6500 ft [1 830–1 980 m], (–AC/AD), 29-03-1964, *Esterhuysen 30665* (BOL); ridge from Koudeveldberg to Towerkop, ± 6500 ft [1 980 m], (–AC/AD), 31-04-1964, *Esterhuysen 30669* (BOL); between Towerkop and Elandsberg/Koudeveldberg, 6000 ft [1 830 m], (–AC/AD), 28-03-1959, *Esterhuysen 28244* (BOL). 3322 (Oudtshoorn): Swartberg Pass area, Krevasberg, summit, (–?AC), 12-1942, *Stokoe 8996* (BOL).

EASTERN CAPE.—3324 (Steytlerville); Great Winterhoek Mtns, Cockscomb, 5500 ft [1 670 m], (–DB), 30-11-1958, *Esterhuysen 28035* (BOL).

#### REFERENCE

MARAIS, W. & VERDOORN, I.C. 1963. *Sebaea*. *Flora of southern Africa* 26: 171–211.

I.M. OLIVER\* and J.B.P. BEYERS\*

\* Compton Herbarium, National Botanical Institute, Private Bag X7, 7735 Claremont, Cape Town. MS. received: 2001-05-16.

## FABACEAE

### THE IDENTITY OF *MELOLOBIUM LAMPOLOBUM* (PAPILIONOIDEAE)

The genus *Melolobium* is currently being revised and a comprehensive survey of the literature and herbarium specimens has revealed a poorly known species that was recently re-collected. The species was listed by Bentham (1844) as a synonym of *M. collinum* Eckl. & Zeyh. and by Harvey (1862) as a variety of *M. microphyllum* Eckl. & Zeyh., but our studies have shown it to be distinct. The identity of the plant became quite apparent when the original material was discovered in the Paris Herbarium. One of Drège's types clearly shows the diagnostically

different pods of the species. When E. Meyer (Feb. 1836) described the genus *Sphingium*, it had already been described a month earlier as *Melolobium* by Ecklon & Zeyher (Jan. 1836). In subsequent publications some of Meyer's names appear to have been overlooked.

There are two Drège's specimens in the Paris Herbarium. *Drège 6463* (Figure 15A) is a flowering specimen with no locality label. *Drège s.n.* (Figure 15B) is a fruiting specimen with the locality label 'Kendo' in

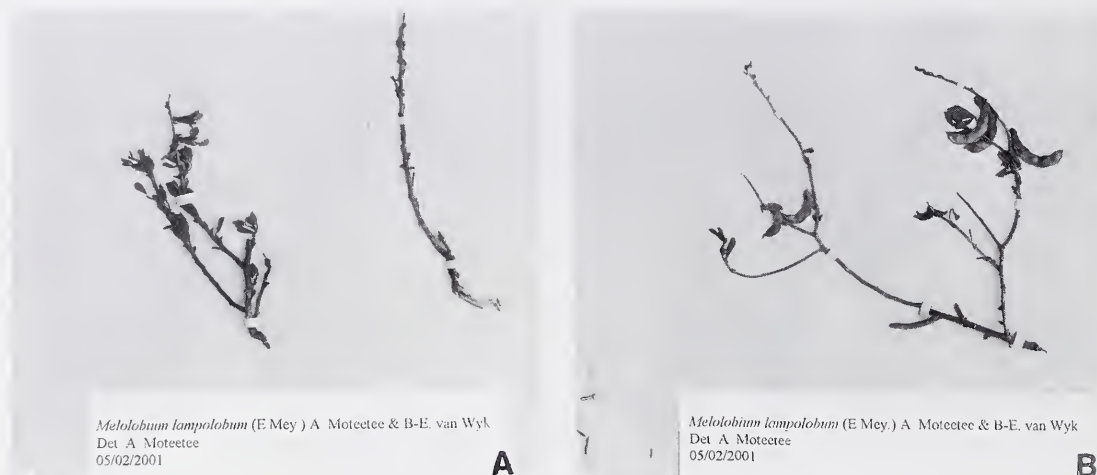


FIGURE 15.—Type specimens of *Melolobium lampolobum* in the Paris Herbarium. A, flowering specimen, Drège 6463 (syntype); B, fruiting specimen Drège s.n. (lectotype).

Drège's handwriting. Because of the diagnostic importance of the fruit and the unambiguous type locality details, the latter is here chosen as lectotype.

***Melolobium lampolobum* (E.Mey.) A.Moteetee & B-E.van Wyk**, comb. nov. Type: Western Cape, 3322 (Oudtshoorn): 'Kendo', (–BD), Drège s.n. (P!, specimen with pods, lectotype, here designated); Drège 6463 (P!, specimen with flowers, syntype).

*Sphingium lampolobum* E.Mey.: 67 (Feb. 1836). *M. microphyllum* L. var. *lampolobum* (E.Mey.) Harv.: 79 (1862).

Woody, strongly spinescent shrublet up to 0.6 m high. *Leaves* stipulate; leaflets oblong to broadly obovate, (3–)5–9 × 2–4 mm, glabrous, apex somewhat mucronate to emarginate; petiole 2–5 mm long; stipules semi-cordate to auriculate, 1–4 × 1–2 mm. *Inflorescence* slender, terminal, 40–60 mm long, many-flowered raceme (10–16 flowers); flowers 7–10 mm long; bracts ovate-lanceolate, 2–3 × 0.5–1.0 mm; bracteoles narrowly ovate to lanceolate, 2–3 × 0.5–0.7 mm. *Calyx* shortly bilabiate, glandular with sessile glands, very sparsely hairy; upper lobes acute, 5–6 mm long, apices obtuse, upper sinus 2–3 mm deep; lower lobes acute, 6–7 mm long, apices obtuse, lower sinuses 0.2–1.0 mm deep. *Corolla* yellow; standard suborbicular, 6–8 × 4–5 mm, with well-developed, channelled claw, 2–3 mm long; wing petals oblong, sculptured, 7–8 × 2–3 mm, with linear claw 3–4 mm long; keel petals shortly half-oblong, apically rounded, 3–4 × 2–3 mm, with linear claw 3–4 mm long. *Androecium* monadelphous, split on its upper side, consisting of four long, basifixed anthers and six short, dorsifixed anthers (alternating with the carinal, intermediate one). *Gynoecium* narrowly oblong, 3.0–3.5 mm long, hairy, with 4 or 5 ovules; style curved, 3–4 mm long. *Fruit* broadly falcate, strongly compressed, 12–18 × 2–4 mm, without glands, almost glabrous, surface distinctly shiny, 2–4-seeded; seeds discoid, light brown, 2.3–2.5 mm diam. (side view). Figure 16.

*Diagnostic characters*: the shiny pod of the aptly named *M. lampolobum* is a very useful diagnostic feature.

Unlike many other related species, the pods are devoid of both sessile and stalked glands. The glabrous, obcordate leaflets and general morphology indicate an affinity to *M. exudans* Harv., the only other species in the entire genus with glabrous leaves. *M. lampolobum* differs from the latter in the strongly spiny, curved branches (slightly spiny in *M. exudans*), pubescent stems (glabrous in *M. exudans*) and glabrescent pods (glandular and hairy in *M. exudans*). Because of its branching pattern and the rigid spines, this species can be confused with *M. candicans* (E. Mey.) Eckl. & Zeyh., from which it differs in the dark brown and pubescent branches (distinctly white-tomentose in most forms of the latter), larger leaves, falcate, shiny pods (straight and densely hairy in *M. candicans*) and longer inflorescences with more flowers.

*Distribution and habitat*: the known distribution of *M. lampolobum* is shown in Figure 17. It occurs at lower altitudes near Robertson and further northeast in the mountains of the Little Karoo in the southern part of Western Cape, extending from the western end of Anysberg along the Klein and Groot Swartberg Mountains as far east as Oudtshoorn. The plants grow in mountain karoo scrub and on rocky slopes, at altitudes of 900 to over 1 500 m.

#### *Additional specimens examined*

WESTERN CAPE.—3319 (Worcester): Vrolijkheid, Robertson, (–DD), *Van der Merve* 3001 (PRE). 3320 (Montagu): Karoo Garden, Whitehill, (–BA), *Compton* 11213 (NBG); western end of Anysberg at Booplaas Farm, (–BC), *C.M. van Wyk* 1080 (PRE); 16.6 km SSE of Laingsburg, (–BD), *B-E. van Wyk* 2143, 2145 (JRAU). 3321 (Ladismith): Ladismith, (–AD), *Bayliss* 2817 (NBG); Groot Swartberg, (–BD), *Marshall* 234 (JRAU, PRE); Swartberg Mountains next to Gamkaskloof, (–BD), *Vlok* 1489 (PRE); range N of Sandberg, (–DA), *Wurts* 1393 (NBG).

#### ACKNOWLEDGEMENTS

We thank the curators of the cited herbaria for loans of specimens. The Government of Lesotho and the National Research Foundation are thanked for financial support.





FIGURE 16.—*Melolobium lampolobum*. A, abaxial view of leaf with stipules; B, adaxial view of young leaf with stipules; C, lateral view of flower; D1, abaxial view of bract; D2 abaxial view of bracteoles; E, calyx opened out with upper lobes to left; F, standard petal; G, wing petal; H, keel petal; I1, long, basifixed anther; I2, carinal (intermediate) anther; I3, short, dorsifixed anther; J, pistil; K, lateral view of pod. Scale bars: A–K, 1 mm.

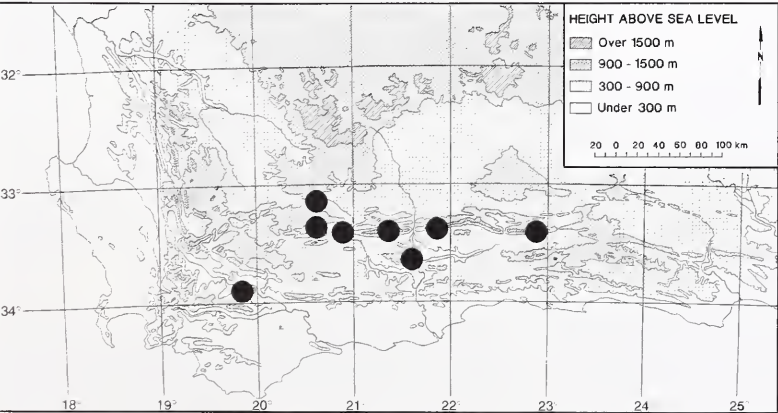


FIGURE 17.—The known distribution of *Melolobium lampolobum*.

## REFERENCES

- BENTHAM, G. 1844. Enumeration of Leguminosae, indigenous to southern Asia and central and southern Africa. In J.D. Hooker, *London Journal of Botany* 3: 350–353.
- ECKLON, C.F. & ZEYHER, C.L.P. 1836. *Enumeratio plantarum Africae australis extratropicae*: 188–190. Perthes & Besser, Hamburg.
- HARVEY, W.H. 1862. Leguminosae. In W.H. Harvey & O.W. Sonder, *Flora capensis* 2: 77–81. Hodges Smith, Dublin.
- MEYER, E.H.F. 1836. *Commentariorum de plantis Africae australioris*: 65–67. Leopoldum Voss, Leipzig.
- A. MOTEETEE\* and B-E. VAN WYK\*

---

\* Department of Botany, Rand Afrikaans University, P.O. Box 524, 2006 Auckland Park, Johannesburg.  
MS. received: 2001-03-19.

# Taxonomic significance of inflorescences, floral morphology and anatomy in *Passerina* (Thymelaeaceae)

C.L. BREDEKAMP\* and A.E. VAN WYK\*\*

**Keywords:** anatomy, androecium, exotegmen, flower, gynoecium, morphology, *Passerina*, phylogeny, taxonomy, Thymelaeaceae, vasculature

### ABSTRACT

Comparative studies were undertaken on the inflorescence, bracts and floral morphology of all taxa of the genus *Passerina* L. in southern Africa. Information is given in tabular form and a key based on bract morphology is presented. Floral morphology supported the status of the infrageneric taxa and also proved to be of taxonomic significance in the genus. Controversy surrounding the interpretation of a number of floral morphological structures in *Passerina* has been resolved. Morphological and anatomical evidence allowed a re-interpretation of the structure of the receptacle, hypanthium and sepals, ovary type and position, structure of the seed coat, ovule type and position, obturator, fruit and seed. On this basis an authentic generic description of the floral morphology was compiled. *Passerina* is distinguished by the following set of characters, a very short floral receptacle, tubular hypanthium, petaloid calyx, absence of petals and petaloid scales, diplostemonous dimorphic androecium, extrorse anthers, superior ovary, anatropous, ventrally epitropous ovule, an obturator of elongated cells, a 1-seeded berry or an achene and tegmic seed with nuclear endosperm becoming cellular throughout. On this basis the flower in *Passerina* is considered a phylogenetically advanced structure, supporting the view that the genus is advanced within the Thymelaeoideae. The proposed taxonomic relationship between Thymelaeaceae and Malvales is confirmed by floral morphological evidence.

### CONTENTS

Introduction	213
Materials and methods	216
Terminology	216
Phylogeny	216
Results	216
Inflorescences	216
Bracts	218
Key to taxa based on bract characters	218
Generic description of floral morphology	219
Generic description of floral anatomy (as seen in transverse section)	219
Floral morphology at species level	223
Discussion	223
Inflorescence	223
Bracts	223
Floral morphology and anatomy at generic level	223
Floral and fruit morphology at species level	232
Less important taxonomic characters	234
Taxonomic relationships	234
Speculations on phylogeny	235
Systematic value	235
Conclusions	235
Acknowledgements	236
References	236

### INTRODUCTION

The infrageneric taxonomy of *Passerina* L. is a problem, due to the apparent lack of marked morphological differences between species. The latest revision by Thoday (1924), is now mostly outdated.

Most species of *Passerina* are endemic to the Cape Floristic Region and adapted to a Mediterranean or semi-Mediterranean climate. The distribution of *P. sp. nov.* 4 and *P. montana* extends eastwards and northwards along the eastern mountains and Great Escarpment of southern Africa, predominantly summer rainfall areas. The species are apparently all wind-pollinated.

The controversy surrounding the interpretation of certain floral structures in the genus became obvious during the present study. Heinig (1951) did not include *Passerina* in her study of the floral morphology of the Thymelaeaceae. From the sexual system of Linnaeus (1781, 1784) to Domke (1934), floral morphology played an integral part in the intrafamilial classification of the Thymelaeaceae and in the circumscription of the family (Table 1). Between ± 1960 and 1996, vast leaps were taken in the classification of the flowering plants by making use of anatomical, floral, palynological, embryological and chemical evidence. During this period, disagreement on the circumscription of the Thymelaeaceae was common (Table 2). Since 1990, many higher-level phylogenetic relationships in angiosperms were based on evidence from *rbcL* and 18S nuclear ribosomal DNA sequence data. In many cases these studies confirmed previously proposed phylogenetic patterns and trends within the family, based on morphological evidence; in other cases, however, profound changes in the circumscription and relationships of the Thymelaeaceae were suggested (Table 3).

The present paper emanated from a monographic study of the genus currently in progress. Available evidence suggests the presence of at least four new species and four new subspecies, to be added to 16 previously recognized species, mostly endemic to southern Africa (Thoday 1924; Bond & Goldblatt 1984) (Table 4). Here we report on a comparative morphological study of the inflorescence, bract, flower, fruit and seed. Specific

\* National Botanical Institute, Private Bag X101, 0001 Pretoria.  
\*\* H.G.W.J. Schweickhardt Herbarium, Department of Botany, University of Pretoria, 0002 Pretoria.  
MS. received: 2000-08-22.



TABLE 1.—Classification of *Passerina* within the Thymelaeaceae according to different authors, based mainly on floral, fruit and seed morphology

Rank	Wikstrom 1818	Endlicher 1837, 1847	Meisner 1857	Bentham & Hooker 1880	Gilg 1891, 1894	Leandri 1930	Donke 1934
Undefined	Thymelaeaceum						
Class		Thymelaeae		Thymelaeaceae			
Order		Daphnoideae				Thymelaeaceae	Thymelaeaceae
Family							
Subfamily							
Tribe		Thymelinae		Euthymelaeaceae	Thymelaeoideae	Thymelaeoideae	Thymelaeoideae
Subtribe		Passerineae	Gnidaeae		Daphneae	Thymelaeoideae	Gnidaeae
Series			Diplostemonaceae		Passeriniinae	Passeriniinae	Passeriniinae
Division	Octandria			Series 1			
Inflorescence, floral, fruit and seed morphology at genus level							
Inflorescence		flowers lateral					terminal spikes
Floral arrangement		perigynous	perigynous			perigynous	
Floral tube		perigone, infundibular, limb 4-fid	calyx tube hypocrateriform, persistent	perianth articulate above ovary	receptacle cylindric, articulate in upper half	floral tube: fusion of 4 external whorls, articulate	calyx tube flask-shaped, articulate
Calyx	0		limb 4-partite				4-lobed
Corolla	infundibular, 4-fid, persistent	scales 0	petaloid scales 0	perianth scales 0	petaloid scales 0	petaloid scales 0	petals 0
Androecium (A)	A = 8	diplostemonous, A = 8, in incisions of perigone	A = 8, exserted, alternating with sepals	diplostemonous, exserted	diplostemonous, A = 8	diplostemonous, A = 8	diplostemonous, A = 8
Gynoecium (G)		unilocular, ovule pendulous		unilocular, ovule single			unilocular, ovule single
Fruit	nux	nux	nucula, pericarp crustaceous	indehiscent			berry or achene
Seed	1-seeded	1-seeded					black, crustaceous testa, micropyle beak-like

TABLE 2.—Classification of *Passerina* within the Thymelaeaceae according to different authors, based on morphological, anatomical, palynological, embryological and chemical characters

Rank	Melchior 1964	Hutchinson 1973	Dahlgren 1975a, b	Dahlgren 1980, Dahlgren & Thorne 1984	Cronquist 1981, 1988	Thorne 1992a, b	Takhtajan 1997
Undefined Class	Thymelaeales						
Subclass					Magnoliopsida	Angiospermae (Magnoliopsida) Dicotyledonae (Magnoliidae)	Dilleniidae
Superorder					Rosidae	Malvnae	Euphorbiae
Order						Euphorbiales	Thymelaeales
Family	Thymelaeaceae	Thymelaeaceae	Thymelaeaceae	Thymelaeaceae Thymelaeales Thymelaeaceae (= Dilleniiflorae) Thymelaeaceae (excluded from Myrtales (1984))	Myrtales	Thymelaeaceae	Thymelaeaceae
Subfamily	Thymelaeoideae					Thymelaeoideae	
Tribe	Thymelaeae (= <i>Gnidieae</i> )						
Subtribe							
Series							
Division							
Relationships	Myrtales: perianth tube Malvales: pollen morphology	placed between Bixales and Proteaceae	placed between Dilleniaceae (including Malvales) and Myrtaceae	Myrtales: anatomical evidence; Euphorbiales— Malvales: chemical, embryological, palynological evidence	Myrtales: strongly perigynous, polypetalous to apetalous flowers. Other families: pseudomonomerous ovary, crotonoid pollen	Euphorbiaceae, Simmondsiaceae, Dichapetalaceae, Gonystylaceae	Gonystylaceae only other family in order
Character	Tribe	Family	Order	Family	Family	Family	Family
Flower		hypogynous, bisexual, wind-pollinated calyx tube	hypogynous, bisexual	perigynous, 4-merous			bisexual
Floral tube	perianth tube articulated		hypanthium	cylindrical, brightly coloured hypanthium			calyx tube cylindric
Calyx	4-lobed	perianth tubular, 4-lobed, imbricate		4-lobed, arising from upper rim of hypanthium			lobes imbricate
Corolla		petals or stamens 0	petals or scale-like structures 0	petaloid scales considered as true petals (Dahlgren & Van Wyk 1988)			petaloid appendages 0
Androecium (A)		diplostemonous	diplostemonous	diplostemonous			diplostemonous
Gynoecium (G)	pseudomonomerous	ovary superior	unilocular; ovules pendulous, epitropous, bitegmic, crassinucellate; endosperm nuclear	pseudomonomerous; ovules pendulous			style sublateral; stigma papillose; carpels 2, mono- locular; ovule solitary
Fruit		indehiscent	nut or drupe	indehiscent			indehiscent, nut-like, baccate, or drupaceous, enveloped by base of persistent calyx tube
Seed		solitary	endosperm scanty; embryo straight	endosperm scanty; embryo straight			caruncle-like or tail-like appendage, without aril; embryo straight; endo- sperm scanty

TABLE 3.—Classification of the Thymelaeaceae according to different authors, based on molecular data

Rank	Conti <i>et al.</i> 1996	APG 1998*	Alverson <i>et al.</i> 1998	Magallón <i>et al.</i> 1999
Undefined		Eudicots		Eudicot Clade
Supraordinal subgroup		Core Eudicots		Core Eudicots
Clade (Subclass)	Rosids	Rosids (subclass Rosidae)	Rosidae	Rosid Clade: Geraniaceae, Capparales, Sapindales, Malvales, Myrtales, Core Rosids
Subgroup	Expanded Malvales: Thymelaeaceae, Sarcolaenaceae, Malvales	Eurosids II	Expanded Malvales: Core Malvales, Thymelaeacean Clade, Bixalean Clade, Diptero carpalean Clade	Expanded Malvales: Malvales, Thymelaeaceae, Sarcolaenaceae, Diptero carpalean Clade, Cistaceae, Sphaerocephalaceae, Neuradaceae, <i>Muntingia</i>
Order		Malvales		
Family	Thymelaeaceae (excluded from Myrtales)	Thymelaeaceae	Thymelaeacean clade	Thymelaeaceae
Relationships	sister groups of Expanded Malvales: Myrtales, Sapindales, Expanded Capparales	sister group: Myrtales	sister groups of Expanded Malvales: Expanded Capparales, Sapindales, Myrtales	sister group of Malvales: Thymelaeaceae, Sarcolaenaceae, Diptero carpalean basal to Malvales

\* Angiosperm Phylogeny Group.

results in leaf anatomy, indicating the arrangement of taxa in *Passerina* (Bredenkamp & Van Wyk 2001), are associated with floral morphological structures as well as fruit and seed types in the present study.

#### MATERIALS AND METHODS

As far as possible, material was collected from at least five different localities for every taxon. Live and preserved (dried and in liquid preservatives) material of all the species, subspecies and varieties in *Passerina* was studied (Table 4). Illustrations were made from herbarium material by means of a drawing tube. Measurements were taken by using a dissection microscope and a calibrated eyepiece.

Flowers were fixed and stored in a 0.1 M phosphate-buffered solution at pH 7.4, containing 2.5% formaldehyde, 0.1% glutaraldehyde and 0.5% caffeine [modified Karnovsky fixative; Karnovsky (1965)]. Light microscopy (LM) was used to study the floral anatomy of *P. ericoides* (Bredenkamp 956, 962), which has fleshy fruit and *P. vulgaris* (Bredenkamp 944, 951) with dry fruit. As the flowers are quite small, whole flower buds, flowers directly after anthesis and young fruits enveloped in the floral tube were washed in water, dehydrated and embedded in glycol methacrylate (GMA) following the methods of Feder & O'Brien (1968). Embedded floral material was serially sectioned from the base of the receptacle to the anthers. Sections were stained in toluidine blue 'O', subjected to the periodic acid-Schiff's (PAS) reaction and mounted in Entellan (Art. 7961, E. Merck, Darmstadt).

#### Terminology

Terminology is used according to the following authorities: inflorescences (Weberling 1983, 1989; Weberling & Herkomm 1989); hypanthium (Bunniger 1972; Dahlgren 1975a, b, 1980; Dahlgren & Thorne 1984); stamen morphology (Heinig 1951; Fahn 1967; Noel 1983);

gynoecium (Heinig 1951; Davis 1966; Corner 1976); fruit (Spjut 1994).

#### Floral envelope

The authors regard the floral envelope ('outer floral whorl') as a hypanthium (fused calyx and androecium), differentiating into four petaloid sepals and a diplostemonous androecium, arising from the hypanthium rim at the separation of the sepals. For the description of colour, texture and measurement of total floral length, only the hypanthium and sepals are considered—the stamens are excluded.

#### Phylogeny

Speculations on phylogeny are based on prevailing family characters representing the ancestral state and derived characters, indicating a reduction in tissue at genus and species levels, considered as possibly advanced. A cladistic analysis based on anatomical and morphological characters in *Passerina* is scheduled for the final stages of the study.

#### RESULTS

##### Inflorescences

*Polytelic synflorescences* present in all species; main florescences and co-florescences spicate (Figures 1A; 2A), often extended, forming multiflowered polytelic florescences in most species, sometimes strongly reduced (*P. burchellii*) (Table 5). *Proliferating spikes* with inflorescence apex growing out and returning to vegetative growth, common; main florescences and co-florescences subterminal. *Spikes* sometimes artificially resembling terminal subcapitulate inflorescences, but each characterized by two terminal leaves with axillary blind-ending rudimentary flowers, enveloping minute growing point (*P. montana*, *P. paleacea*, *P. glomerata*, *P. sp. nov.* 3); proliferating growth less common in subcapitulate inflorescences.



TABLE 4.—*Passerina* specimens examined and housed at PRE

Species	Collector	Locality
<i>burchellii</i> Thoday	<i>Bredenkamp 1545</i> <i>Bolus 687*, Stokoe 2542</i>	WESTERN CAPE.—3319 (Worcester): Jonaskop, (–DC). WESTERN CAPE.—3419 (Caledon): Baviaanskloof, Genadendal, (–BA).
<i>comosa</i> C.H.Wright	<i>Thoday 212</i> <i>Andrae 1288*</i> <i>MacDonald 2125</i>	WESTERN CAPE.—3320 (Montagu): Montagu District, near Concordia, (–CD). WESTERN CAPE.—3321 (Ladismith): Seweweekspoort, (–AD).
<i>drakensbergensis</i> Hilliard & B.L.Burt	<i>Edwards 974</i> <i>Bredenkamp 1018, 1019, 1020, 1021*</i>	KWAZULU-NATAL.—2828 (Bethlehem): Royal Natal National Park, (–DB). KWAZULU-NATAL.—2829 (Harrismith): Ndodema Gorge, Cathedral Peak Forest Reserve, (–CD).
<i>ericoides</i> L.	<i>Bredenkamp 956*</i> <i>Bredenkamp 962*</i> <i>Taylor 4042</i>	WESTERN CAPE.—3318 (Cape Town): Milnerton, (–CD). WESTERN CAPE.—3418 (Simonstown): Cape Maclear, (–AD). WESTERN CAPE.—3419 (Caledon): Pearly Beach, (–CB).
<i>falcifolia</i> C.H.Wright	<i>Bredenkamp 917*</i> <i>Bredenkamp 915</i> <i>Tyson 1449</i>	WESTERN CAPE.—3323 (Willowmore): Gouna State Forest, (–CC). WESTERN CAPE.—3324 (Steytlerville): opposite Tsitsikama Lodge, (–CD). WESTERN CAPE.—3423 (Knysna): Knysna, (–AA).
<i>filiformis</i> L. subsp. <i>filiformis</i>	<i>Boucher 2833</i> <i>Bredenkamp 1039*</i> <i>Schlechter 5125*</i> <i>Taylor 1542</i>	WESTERN CAPE.—3118 (Van Rhynsdorp): Clanwilliam Dist., Diepkloof S of Verlore- vlei, (–AD). WESTERN CAPE.—3318 (Cape Town): Signal Hill, (–CD). WESTERN CAPE.—3218 (Clanwilliam): Alexander's Hoek, (–BC). WESTERN CAPE.—3218 (Clanwilliam): Malmesbury Div., Vredenburg, Steenberg's Cave, (–CC).
<i>galpinii</i> C.H.Wright	<i>Bredenkamp 946*</i> <i>Bredenkamp 932</i> <i>Bredenkamp 933</i> <i>Bredenkamp 923</i>	WESTERN CAPE.—3420 (Bredasdorp): De Hoop Nature Reserve, (–AD). WESTERN CAPE.—3421 (Riversdale): Riethuiskraal, (–AD). WESTERN CAPE.—3421 (Riversdale): Still Bay, (–AD). WESTERN CAPE.—3422 (Mossel Bay): Mossel Bay, (–AA).
<i>glomerata</i> Thunb. subsp. <i>glomerata</i>	<i>Bredenkamp 988</i> <i>Bredenkamp 994</i> <i>Bredenkamp 1002</i> <i>Bredenkamp 984, 985*</i> <i>Bredenkamp 977</i> <i>Bredenkamp 973*</i>	WESTERN CAPE.—3219 (Wuppertal): Cederberg Mountains, Eikeboom, (–AC). WESTERN CAPE.—3219 (Wuppertal): Cederberg Mountains, Kromrivier, (–AC). WESTERN CAPE.—3219 (Wuppertal): Cederberg Mountains, Algeria, (–AC). WESTERN CAPE.—3219 (Wuppertal): Citrusdal, Pickenierskloof Pass, (–CD). WESTERN CAPE.—3219 (Wuppertal): Groenfontein, (–DC). WESTERN CAPE.—3319 (Worcester): Tulbagh, (–AC).
<i>glomerata</i> Thunb. subsp. nov.	<i>Stokoe 8040</i> <i>Esterhuysen 28587*</i>	WESTERN CAPE.—3219 (Wuppertal): Cederberg Mountains. WESTERN CAPE.—3319 (Worcester): Hex River Mountains.
<i>montana</i> Thoday	<i>Giess 13136</i> <i>Bredenkamp 1024</i> <i>Bredenkamp 1025</i> <i>Bredenkamp 889, 890</i> <i>Bredenkamp 893*</i>	NAMIBIA.—2217 (Windhoek): Auas Mountains, Molteblich, (–CA). MPUMALANGA.—2430 (Pilgrim's Rest): World's View, (–DD). MPUMALANGA.—2430 (Pilgrim's Rest): God's Window, (–DD). FREE STATE.—2828 (Bethlehem): Golden Gate National Park, (–DA). FREE STATE.—2927 (Maseru): Ladybrand, (–AB).
<i>obtusifolia</i> Thoday	<i>Bredenkamp 971</i> <i>Bredenkamp 967</i> <i>Bredenkamp 1033, 1034</i> <i>Bredenkamp 929</i> <i>Bredenkamp 919*</i> <i>Bredenkamp 960*</i> <i>Bredenkamp 961</i> <i>Bredenkamp 952</i> <i>Bredenkamp 950</i> <i>Bredenkamp 949</i> <i>Bredenkamp 940</i>	WESTERN CAPE.—3319 (Worcester): Karoo National Botanical Garden, (–CB). WESTERN CAPE.—3319 (Worcester): Jonaskop, (–CD). WESTERN CAPE.—3321 (Laingsburg): Seweweekspoort, (–AD). WESTERN CAPE.—3321 (Ladismith): Rooiberg, (–CB). WESTERN CAPE.—3322 (Oudtshoorn): Perdepoort, (–CD). WESTERN CAPE.—3418 (Simonstown): Kommetjie, (–AB). WESTERN CAPE.—3418 (Simonstown): Cape Maclear, (–AD). WESTERN CAPE.—3418 (Simonstown): Harold Porter National Botanical Garden, (–BD). WESTERN CAPE.—3420 (Bredasdorp): De Hoop Nature Reserve, (–AD). WESTERN CAPE.—3420 (Bredasdorp): Waenhuiskrans, (–CA). WESTERN CAPE.—3421 (Riversdale): Puntjie, (–AC).
<i>paleacea</i> Wikstr.	<i>Bredenkamp 1035</i> <i>Jangle 156*</i> <i>Thoday 100</i>	WESTERN CAPE.—3418 (Simonstown): Rondevlei Nature Reserve, (–BA). WESTERN CAPE.—3418 (Simonstown): Rondevlei Nature Reserve, (–BA). WESTERN CAPE.—3418 (Simonstown): Riet Valley, Cape Flats, (–BA).
<i>pendula</i> Eckl. & Zeyh.	<i>Fourcade 3043</i> <i>Bredenkamp 908, 909*</i>	EASTERN CAPE.—3324 (Steytlerville): Zuur Anys, (–CB). EASTERN CAPE.—3325 (Port Elizabeth): Groendal Nature Reserve, (–CB).
<i>rigida</i> Wikstr.	<i>Ward 7211</i> <i>Bredenkamp 1013*</i> <i>Bredenkamp 899</i> <i>Bredenkamp 898</i> <i>Bredenkamp 897</i> <i>Bredenkamp 911</i> <i>Bredenkamp 914*</i> <i>Bredenkamp 905</i> <i>Bredenkamp 900</i> <i>Bredenkamp 926</i> <i>Bredenkamp 907</i> <i>Bredenkamp 901</i> <i>Bredenkamp 951*</i> <i>Bredenkamp 944*</i> <i>Bredenkamp 924</i>	KWAZULU-NATAL.—2832 (Mtubatuba): St Lucia Park, (–AD). KWAZULU-NATAL.—3130 (Port Edward): Umtamvuna River Mouth, (–AA). EASTERN CAPE.—3326 (Grahamstown): Kenton-on-Sea, (–DA). EASTERN CAPE.—3326 (Grahamstown): Port Alfred, (–DB). EASTERN CAPE.—3327 (Peddie): Kleinmond West, (–CA). EASTERN CAPE.—3424 (Humansdorp): Jeffreys Bay, (–BB). EASTERN CAPE.—3324 (Steytlerville): en route to Kareedouw, (–CD). EASTERN CAPE.—3325 (Port Elizabeth): Colchester, (–DB). EASTERN CAPE.—3326 (Grahamstown): Grahamstown, (–AD). WESTERN CAPE.—3321 (Ladismith): en route to Korenthe River Dam, (–CC). EASTERN CAPE.—3325 (Port Elizabeth): Groendal Nature Reserve, (–CB). EASTERN CAPE.—3326 (Grahamstown): Grahamstown, (–AD). WESTERN CAPE.—3418 (Simonstown): Betty's Bay, Harold Porter NBG, (–BD). WESTERN CAPE.—3420 (Bredasdorp): Cape Infanta, (–BD). WESTERN CAPE.—3422 (Mosselbaai): Kleinbrak, (–AA).
<i>rubra</i> C.H.Wright	<i>Bredenkamp 911</i> <i>Bredenkamp 914*</i> <i>Bredenkamp 905</i> <i>Bredenkamp 900</i> <i>Bredenkamp 926</i> <i>Bredenkamp 907</i> <i>Bredenkamp 901</i> <i>Bredenkamp 951*</i> <i>Bredenkamp 944*</i> <i>Bredenkamp 924</i>	WESTERN CAPE.—3220 (Sutherland): Roggeveld Escarpment, (–AB). WESTERN CAPE.—3319 (Worcester): Waboomberg, Ceres, (–AD).
<i>vulgaris</i> Thoday	<i>Goldblatt &amp; Manning 8627</i> <i>Bredenkamp 1044, 1046, 1047</i> <i>Oliver 9281*</i>	WESTERN CAPE.—3218 (Clanwilliam): Northern Cederberg Mountains, (–BB). WESTERN CAPE.—3322 (Oudtshoorn): Swartberg Pass, Prince Albert area, (–AC). WESTERN CAPE.—3322 (Oudtshoorn): Montagu Pass, (–CD). EASTERN CAPE.—3323 (Willowmore): Kouga Mountains, (–DA). EASTERN CAPE.—3324 (Steytlerville): Cockcomb, Uitenhage area, (–BD). KWAZULU-NATAL.—2930 (Pietermaritzburg): Table Mountain, (–CB). KWAZULU-NATAL.—3030 (Port Shepstone): Oribi Gorge, (–CB). KWAZULU-NATAL.—3130 (Port Edward): Umtamvuna River Bridge, (–AA).
sp. nov. 1	<i>Bredenkamp 1013*</i> <i>Bredenkamp 899</i> <i>Bredenkamp 898</i> <i>Bredenkamp 897</i> <i>Bredenkamp 911</i> <i>Bredenkamp 914*</i> <i>Bredenkamp 905</i> <i>Bredenkamp 900</i> <i>Bredenkamp 926</i> <i>Bredenkamp 907</i> <i>Bredenkamp 901</i> <i>Bredenkamp 951*</i> <i>Bredenkamp 944*</i> <i>Bredenkamp 924</i>	WESTERN CAPE.—3220 (Sutherland): Roggeveld Escarpment, (–AB). WESTERN CAPE.—3319 (Worcester): Waboomberg, Ceres, (–AD).
sp. nov. 2	<i>Esterhuysen 12189, 26859*</i>	WESTERN CAPE.—3218 (Clanwilliam): Northern Cederberg Mountains, (–BB).
sp. nov. 3	<i>Stokoe 9302</i> <i>Schlechter 5846</i> <i>Esterhuysen 10734*</i> <i>Esterhuysen 28006*</i>	WESTERN CAPE.—3322 (Oudtshoorn): Swartberg Pass, Prince Albert area, (–AC). WESTERN CAPE.—3322 (Oudtshoorn): Montagu Pass, (–CD). EASTERN CAPE.—3323 (Willowmore): Kouga Mountains, (–DA). EASTERN CAPE.—3324 (Steytlerville): Cockcomb, Uitenhage area, (–BD).
sp. nov. 4	<i>Killick 238</i> <i>Bredenkamp 1016, 1017</i> <i>Van Wyk &amp; Bredenkamp 1, 1012</i> <i>Bredenkamp 1327*</i> <i>Gillet 4537</i> <i>Keet s.n.</i>	KWAZULU-NATAL.—2930 (Pietermaritzburg): Table Mountain, (–CB). KWAZULU-NATAL.—3030 (Port Shepstone): Oribi Gorge, (–CB). KWAZULU-NATAL.—3130 (Port Edward): Umtamvuna River Bridge, (–AA). KWAZULU-NATAL.—3130 (Port Edward): Mkambati Nature Reserve, (–AC). WESTERN CAPE.—3422 (Mossel Bay): en route to Knysna from George, (–BB). WESTERN CAPE.—3423 (Knysna): Knysna, Redlands, (–AA).

\* Illustrated specimens; • specimens used for light microscopy.

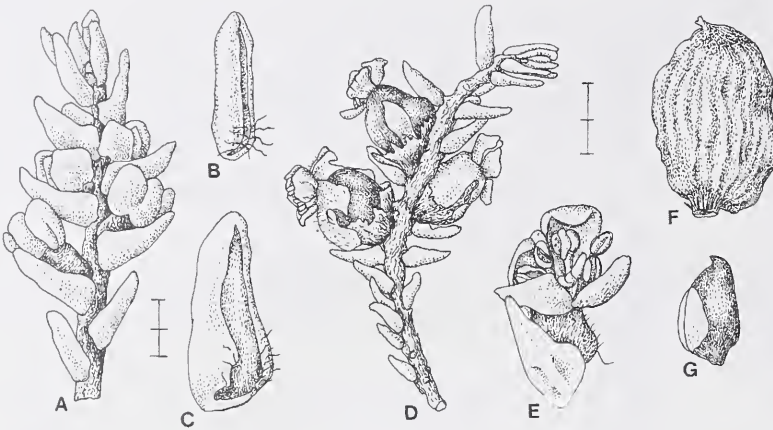


FIGURE 1.—*Passerina ericoides*. A–G, Bredenkamp 962. A, young inflorescence; B, leaf exposing adaxial surface; C, bract exposing adaxial surface; D, fruiting branchlet; E, flower enveloped by bract; F, fleshy one-seeded berry; G, seed with black tegmen and white fragment of endocarp. A, D,  $\times 10$ ; B, C, E–G,  $\times 20$ . Scale bars: 10 mm.

**Bracts**

*Arrangement* subterminal in proliferating spikes, pseudoterminal in subcapitulate spikes; youngest bracts closest to growing point, enlarging along florescence axis; bracts enveloping flowers and fruits (Figures 1A, D, E; 2A, D), largest after anthesis of flowers, becoming more coriaceous and rounded at fruit set, gradually acquiring leaf shape at proximal end of florescence axis, decussate, sessile, imbricate, often conspicuously enlarged, resulting in longer spikes (*P. falcifolia*, *P. filiformis*, *P. sp. nov.* 4, *P. rubra*). *Lamina* inversely ericoid; adaxial surface (inside) concave, facing inflorescence axis, abaxial surface (outside) convex; cymbiform (boat-shaped) or helmet-shaped; in outline (plane shape), oblong, lanceolate, ovate and obovate to widely ovate and obovate, rhombic and narrowly obtrullate to obtrullate (Figures 3; 4; Table 5); bracts without leaf-like point, length  $\times \frac{1}{2}$  width (2.5–)3.5–4.5(–5.5)  $\times$  (0.9–)1.0–1.5(–2.4)

mm; bracts with leaf-like point, length  $\times \frac{1}{2}$  width (4.0–)5.1–6.3(–7.3)  $\times$  (1.4–)1.5–2.0(–2.6) mm; outside glabrous, seldom tomentose (*P. comosa*, *P. sp. nov.* 3), inside, base or midrib tomentose with glabrous wings or completely comose, tomentose, villous or setose; trichomes nonglandular, uniseriate, mostly strongly spiralled, white; coriaceous or chartaceous, rugose or smooth,  $\pm$  succulent or thin, outline of epidermal cells often macroscopically visible; often  $\pm$  3–5-ribbed or reticulately veined on each side of main vein. *Wings* absent, or bordering lamina or distinct from lamina and conspicuously rounded or bullate; mostly glabrous, coriaceous, chartaceous or membranous, often straw-coloured and rosytinged. *Base* sessile or cuneate. *Midrib* strongly developed, forming spine of cymbiform bract, often keeled, extending to form a leaf-like point in many species. *Apex* obtuse, rounded or acute, mostly coriaceous. *Margins* often ciliate to setose (*P. burchellii*, *P. sp. nov.* 4, *P. pendula*).

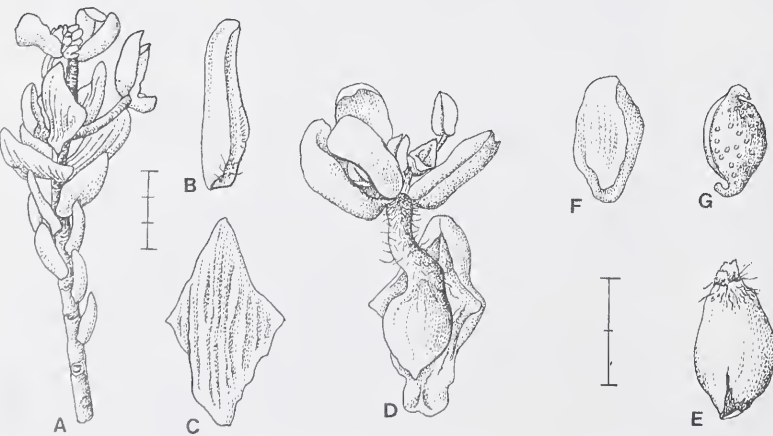


FIGURE 2.—*Passerina vulgaris*, Bredenkamp 944. A, inflorescence; B, leaf exposing adaxial surface; C, bract exposing abaxial surface; D, flower enveloped by bract; E, fruit enveloped by hypanthium, with fragmentation at neck base; F, achene; G, seed with black tegmen and white spots. A,  $\times 10$ ; B–G,  $\times 20$ . Scale bars: 10 mm.

**Key to taxa based on bract characters (Figures 3; 4; Table 5)**

- 1a Bracts hairy outside . . . . . *P. comosa* (Figure 3A), *P. sp. nov.* 3 (Figure 3B, C)
- 1b Bracts glabrous outside:
  - 2a Bracts shorter than 4.5 mm:
    - 3a Bracts rhombic in outline:
      - 4a Bracts dark green when fresh, dark brown in dried specimens, coriaceous; membranous wings absent . . . . . *P. burchellii* (Figure 3D)
    - 4b Bracts blue-green (glaucous) in fresh and dried specimens, softly coriaceous; membranous wings present . . . . . *P. pendula* (Figure 3E)



- 3b Bracts variously shaped, but not rhombic in outline:
- 5a Membranous wings present:
- 6a Wings present as membranous rims along lamina margins:
- 7a Lamina convex, ovate to obovate, thinly coriaceous, obscurely ribbed ..... *P. montana* (Figure 3F)
- 7b Lamina helmet-shaped, widely obovate, thinly chartaceous, smooth ..... *P. sp. nov. 2* (Figure 3G)
- 6b Wings variously shaped, but not as membranous rims along lamina margins:
- 8a Wings widely ovate, evenly concave, main vein forming small, obtuse apex ..... *P. paleacea* (Figure 3H)
- 8b Wings oblate or obovate, often bullate:
- 9a Main vein extended into leaf-like point ..... *P. galpinii* (Figure 3I)
- 9b Main vein shortly extended into subacute apex ..... *P. sp. nov. 1* (Figure 3J)
- 5b Membranous wings absent:
- 10a Bracts oblong in outline, apex obtuse ..... *P. ericoides* (Figure 3K)
- 10b Bracts widely ovate or obovate to widely obovate in outline, apex various:
- 11a Bracts widely ovate with distinct, short acute point, glaucous, coriaceous; lamina with 2 or 3 shallow folds ..... *P. rigida* (Figure 3L)
- 11b Bracts obovate to widely obovate, point obtuse to acute, thickly coriaceous; lamina ribbed and reticulate-veined ..... *P. glomerata* subsp. *glomerata* (Figure 4A), *P. glomerata* subsp. nov. 1 (Figure 4B)
- 2b Bracts longer than 4.5 mm:
- 12a Bracts lanceolate and glaucous ..... *P. drakensbergensis* (Figure 4C)
- 12b Bracts variously shaped and coloured, but not lanceolate and glaucous:
- 13a Main vein shortly extended into an acute apex; lamina rhombic to obtrullate, distinctly angled, 4- or 5-ribbed ..... *P. vulgaris* (Figure 4L)
- 13b Main vein extending beyond lamina into a leaf-like point:
- 14a Leaf-like point obtuse at apex; lamina closely 2-ribbed at margins ..... *P. obtusifolia* (Figure 4D)
- 14b Leaf-like point not obtuse; lamina extending into a membranous margin:
- 15a Adaxial (inner) surface of bracts basally to centrally setose or tomentose over entire length of midrib; wings glabrous:
- 16a Midrib and leaf-like point stout and strongly developed, apex acute ..... *P. paludosa* (Figure 4E)
- 16b Midrib shortly extended or forming a straight or filiform, leaf-like point:
- 17a Midrib shortly extended, wings ovate-acuminate, gradually narrowing to a point ..... *P. filiformis* subsp. nov. (Figure 4F)
- 17b Midrib extended, forming a straight or filiform, leaf-like point:
- 18a Midrib extended into a filiform, slightly falcate point; wings widely obovate, narrowing abruptly into a leaf-like point ..... *P. filiformis* subsp. *filiformis* (Figure 4G)
- 18b Midrib extended into a straight point or slightly incurved point; wings ovate with margins hairy in upper half, or obtrullate, narrowing abruptly into a leaf-like point ..... *P. sp. nov. 4* (Figure 4H, I)
- 15b Adaxial (inner) surface of bracts completely villous:
- 19a Midrib extended, leaf-like point falcate; wings  $\pm$  4-ribbed ..... *P. falcifolia* (Figure 4J)
- 19b Midrib shortly extended into a short point, apex acute; wings  $\pm$  5-ribbed ..... *P. rubra* (Figure 4K)

## Generic description of floral morphology

*Flowers* actinomorphic, bisexual, hypogynous. *Floral envelope* membranous during pollination and yellowish in *P. rigida*, *P. paleacea*, *P. sp. nov. 1* and *P. sp. nov. 2*, slightly succulent and greenish in *P. ericoides*, mostly yellow-pink in all other species, dehydrated after shedding of pollen, becoming papyraceous or coriaceous, yellow-pink tones turning red, (4.0–)5.3–7.3(–8.4) mm long. *Pedicel* very short or absent. *Receptacle* very short. *Hypanthium* a membranous to coriaceous cylindric tube; indumentum variable in density, trichomes nonglandular, uniseriate, often spiralled, whitish, density of indumentum at ovary ranging from glabrous to tomentose or strigose; neck (narrowed tube between apex of ovary and sepals) (0.3–)0.6–2.6(–3.0) mm long, density of indumentum ranging from glabrous to tomentose on outside, inside often hairy, abscission tissue not macroscopically discernible, articulation plane absent, after fruiting fragmentation of neck base caused by dehydration and torsification of tissue, shedding sepals and androecium (Figure 2D, E; Table 8) in most species. *Sepals* petaloid (Figures 1E; 2A, D); lobes 4, imbricate in bud (Figure 8C, D), flexed in flower, often setose with up to 5 long trichomes on outer surface and glabrous to tomentose on inner surface; outer lobes cymbiform or concave; inner lobes oblong, elliptic or obovate. *Corolla* absent. *Petaloid scales* absent. *Androecium* dimorphic diplostemonous, inserted at rim of hypanthium, filaments of antipetalous whorl (0.4–)0.7–1.2(–1.5) mm long, anti-

sepalous whorl (1.2–)1.4–2.2(–2.4) mm long; anthers (0.5–)0.7–0.9(–1.1)  $\times$  (0.2–)0.3–0.4(–0.7) mm, subbasifixed, 2-thecous and 4-locular (Figure 9A), extrorse. *Disc* absent. *Ovary* superior, (1.6–)2.0–2.5(–2.7)  $\times$  (0.5–)0.6–1.4(–1.7) mm, bicarpellate during embryonic stage (Bunniger 1972), pseudomonomerous (Heinig 1951) at maturity, placentation parietal, uniloculate, with 1 pendulous ovule laterally attached near top of ovary; style separating laterally from top of ovary, maintaining lateral position in hypanthium neck, reaching beyond hypanthium rim; stigma  $\pm$  globose, mop-like or penicillate (wind-pollination). *Fruit* enveloped by persistent, loosely arranged hypanthium fragmented at neck base or, in some species, fragmenting over widest circumference of fruit, shedding fragmented hypanthium, sepals and androecium (Figures 1D; 2E), in *P. ericoides* (Figure 1F) and *P. rigida* a fleshy 1-seeded berry, 5.3  $\times$  4.0 mm, in all other species (Figure 2F; Tables 6, 7) an achene, pericarp membranous and dry, 2.5  $\times$  1.2 mm. *Seed*: tegmen black and shiny, often with white spots, broadly fusiform with outgrowths at both micropylar and funicular ends (Figures 1G; 2G), 2.2(–2.9)  $\times$  1.2(–1.6) mm.

## Generic description of floral anatomy (as seen in transverse section)

*Receptacle base*: vascular tissue arranged in a central stele from which 8 traces are derived in a single whorl (Figure 5A). *Receptacle at apical position*: carpellary bundles arranged in continuous central cylinder; 8 vas-





FIGURE 3.—Camera lucida drawings of abaxial, lateral and adaxial views of bracts of *Passerina* taxa, arranged according to sequence in key. A, *P. comosa*, Andreae 1288; B–C, *P. sp. nov. 3*, Esterhuysen 10734, 28006; D, *P. burchellii*, Bolus 687; E, *P. pendula*, Bredenkamp 908; F, *P. montana*, Bredenkamp 893; G, *P. sp. nov. 2*, Esterhuysen 26859; H, *P. paleacea*, Bredenkamp 960; I, *P. galpinii*, Bredenkamp 946; J, *P. sp. nov. 1*, Oliver 9281; K, *P. ericoides*, Bredenkamp 962; L, *P. rigida*, Bredenkamp 1013. A–L,  $\times 20$ . Scale bar: 5 mm.

cular bundles, fused sepal and stamen traces occupying peripheral position (Figure 5B); cells at periphery of cortex arranged in rows (abscission tissue), differentiation of inner epidermis of hypanthium and outer epidermis of ovary wall, separating hypanthium from ovary wall (Figure 5C, D). *Hypanthium* irregularly lobed or scalloped; outer and inner epidermis variously hairy; cuticle sometimes strongly developed; 8 vascular bundles stretching over entire length (Figure 5E, F). *Calyx* with 4 imbricate lobes developing at hypanthium rim, each containing 3 vascular bundles; epidermal and hypodermal layers containing large amounts of pigment; spongy parenchyma aerenchymatic (Figure 8C, D; Table 6). *Androecium*: each of the 4 fused commisural sepal and antipetalous stamen bundles (cs–pst) split into 2 sepal lateral bundles (sl) and 1 antipetalous stamen bundle (pst), resulting in the first whorl of 4 antipetalous stamens (situated slightly lower in the hypanthium) and

each sepal containing 3 vascular bundles (Figure 8A, B); each of the 4 fused sepal midrib and antisepalous stamen bundles (s–sst) split into a sepal midrib bundle (s) and an antisepalous stamen bundle (sst), forming the second whorl of 4 antisepalous stamens (Figure 8B, C); anthers extrorse, with wall of locule comprising epidermis and endothecium only, periclinal walls of epidermis thin and folded inwards, cell wall thickenings of endothecium  $\pm$  stellate, with rib-like extensions directed towards epidermis (Figure 9B), partitions between loculi withered and ruptured (Figure 9C), accompanied by final rupturing of outer walls of thecae (Figure 9D). *Ovary base*: wall independent of hypanthium or loosely adhering to hypanthium at distal side away from placenta (Figure 5E, F; Table 6); outer and inner epidermal walls strongly developed, containing ample amounts of tanniniferous substances (Figure 5E) or less sturdy (Figure 5G); mesophyll of densely arranged parenchy-

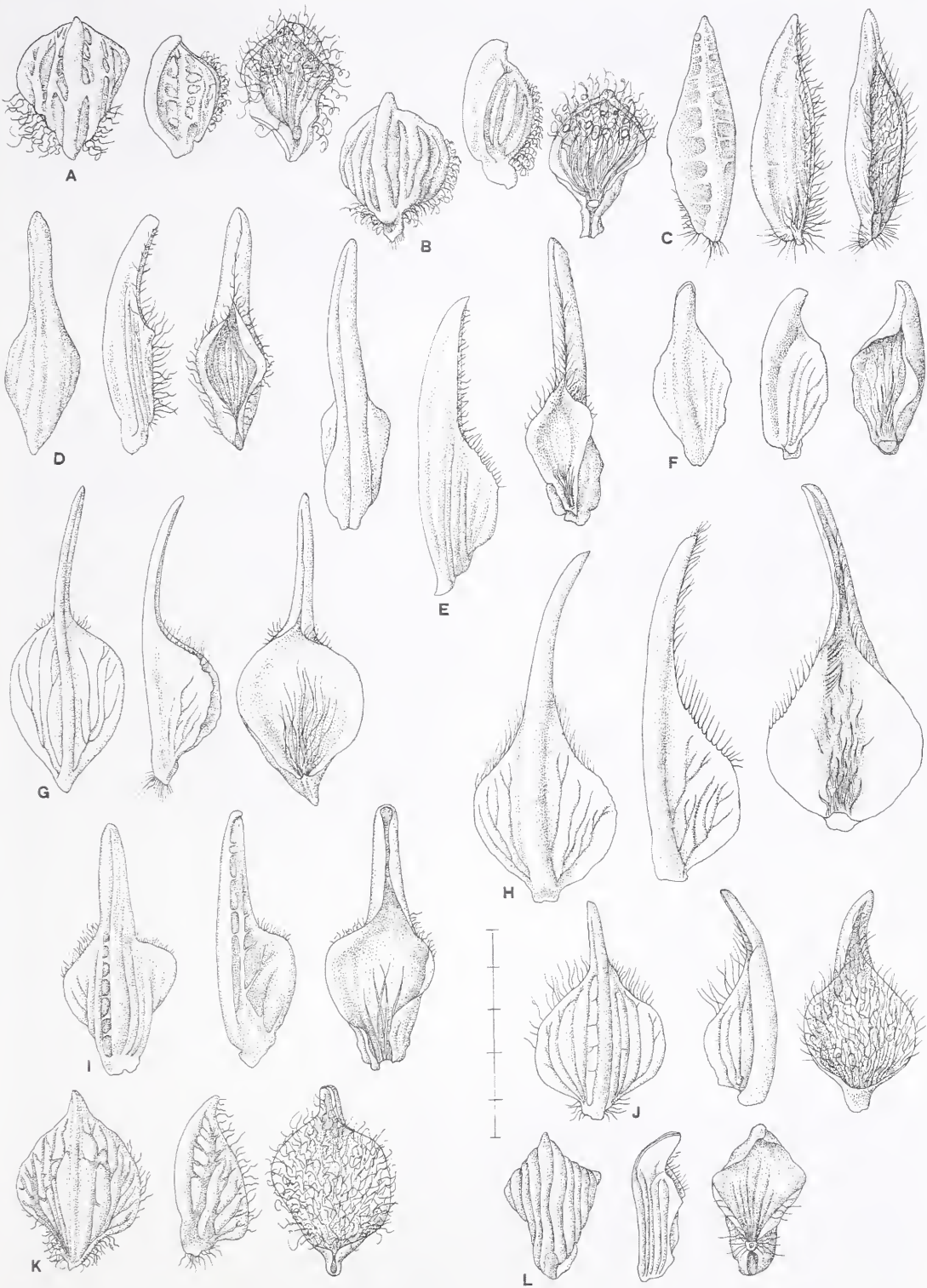


FIGURE 4.— Camera lucida drawings of abaxial, lateral and adaxial views of bracts of *Passerina* taxa, arranged according to sequence in key. A, *P. glomerata* subsp. *glomerata*, Bredenkamp 973; B, *P. glomerata* subsp. nov., Esterhuysen 28587; C, *P. drakensbergensis*, Bredenkamp 1012; D, *P. obtusifolia*, Bredenkamp 919; E, *P. paludosa*, Jangle 156; F, *P. filiformis* subsp. nov., Schlechter 5125; G, *P. filiformis* subsp. *filiformis*, Bredenkamp 1039; H, *P.* sp. nov. 4 from Knysna, Gillett 4537; I, *P.* sp. nov. 4, Bredenkamp 1327; J, *P. falcifolia*, Bredenkamp 917; K, *P. rubra*, Bredenkamp 914; L, *P. vulgaris*, Bredenkamp 944. A–L,  $\times 20$ . Scale bar: 5 mm.

TABLE 5.—Comparison of inflorescences and bracts in *Passerina*. Sequence of taxa according to key based on bract characters (see text)

Taxa	Polytelic inflorescence			Cymbiform bracts			
	subcapitulate	Spikes reduced	Multi-flowered main and co-flourescences	abaxial	Indumentum axial	Size length $\times$ $\frac{1}{2}$ width (mm)	Plane shape
<i>comosa</i>					comose	(3.0–)5.5 $\times$ 1.5(–1.8)	widely ovate, apex acute
sp. nov. 3	X		X	tomentose	comose	(4.5–)4.9 $\times$ 1.5(–1.8)	widely ovate, apex acute
<i>burchellii</i>		X			villous	(3.2–)3.5 $\times$ 1.5	rhombic, apex involute, acute
<i>pendula</i>					comose	(3.0–)4.2 $\times$ 1.0(–1.5)	rhombic, apex obtusely angled
<i>montana</i>	X				villous	(3.2–)4.0 $\times$ 0.9(–1.6)	ovate to obovate, apex subacute
<i>paleacea</i>	X				villous, wing borders glabrous	(2.5–)2.7 $\times$ 1.2(–1.9)	widely ovate, apex obtuse
<i>galpinii</i>			X		midrib tomentose, wings glabrous	(3.6–)4.5 $\times$ 1.1(–2.2)	oblate, leaf-like point, apex subacute
sp. nov. 1			X		midrib tomentose, wings glabrous	(3.2–)3.5 $\times$ 1.4(–1.9)	widely obovate, apex subacute
sp. nov. 2			X		setose	3.1 $\times$ 1.4	helmet-shaped, widely obovate, apex subacute
<i>ericoides</i>			X		villous	3.6 $\times$ 1.5	leaf-like, oblong, obtuse
<i>rigida</i>			X		villous	(2.6–)3.4 $\times$ 1.4(–1.9)	widely ovate, distinct, short, acute point
<i>glomerata</i> subsp. <i>glomerata</i>	X				villous	4.0 $\times$ 1.4(–2.4)	obovate to widely obovate, point obtuse
<i>glomerata</i> subsp. nov.	X				villous	(2.5–)2.9 $\times$ 1.5	obovate to widely obovate, point obtuse to acute
<i>drakensbergensis</i>			X		villous	5.5 $\times$ 1.5	lanceolate, apex obtuse to acute
<i>obtusifolia</i>			X		setose	(4.0–)5.8 $\times$ 1.5(–1.7)	narrowly obtrullate, point leaf-like, apex obtuse
<i>paludosa</i>			X		basally setose, wings glabrous	(5.2–)7.0 $\times$ 1.8(–2.0)	narrowly obtrullate, point leaf-like, apex acute
<i>filiformis</i> subsp. nov.			X		centrally setose, wings glabrous	4.6 $\times$ 1.5	ovate acuminate, gradually narrowing to point
<i>filiformis</i> subsp. <i>filiformis</i>			X		basally to centrally setose, wings glabrous	7.3 $\times$ 2.0	widely obovate, narrowing abruptly into filiform point
sp. nov. 4			X		basally setose, wings glabrous	6.3 $\times$ 1.6	obtrullate, narrowing abruptly into straight, leaf-like point
<i>faicifolia</i>			X		villous	(5.3–)5.8 $\times$ 1.7(–2.0)	widely ovate, narrowing into falcate point
<i>rubra</i>			X		villous	(4.3–)5.1 $\times$ 1.8(–2.0)	widely ovate, with short, acute point
<i>vulgaris</i>			X		shortly villous	(4.4–)5.1 $\times$ 1.4(–1.7)	rhombic to obtrullate, distinctly angled

X, character present.



TABLE 6.—Distinction between *P. ericoides* and *P. vulgaris* based on floral anatomy, seen in t/s (Figures 5; 7; 10)

Floral part	<i>P. ericoides</i> (fruit fleshy)	<i>P. vulgaris</i> (fruit dry)
Hypanthium	Lobed. Outer and inner epidermis hairy (Figure 5E–G).	Scalloped. Outer epidermis hairy, inner epidermis glabrous (Figure 5F, H).
Ovary wall	Independent of hypanthium.  Outer and inner epidermal wall strongly developed, containing tanniniferous substances. Mesophyll of densely arranged parenchyma cells. Dorsal carpellary bundle strongly developed (Figure 5G). Commissural bundles densely arranged, often fused (Figure 5E, G)	Loosely adhering to hypanthium distally away from placenta (Figure 5F). Epidermal walls less sturdy with less tanniniferous substances.  Mesophyll aerenchymatic. Dorsal carpellary bundle rudimentary or absent (Figure 5F, H). Commissural bundles closely arranged, often separate (Figure 5F, H).
Style	Four-lobed. Vascular bundles 4, 1 per lobe (Figure 7C).	Elliptic. Vascular bundles inconspicuously arranged in a row along long axis of elliptic style (Figure 7D).
Fruit	Pericarp fleshy: exocarp tanniniferous, mesocarp of a few layers of parenchyma, endocarp disintegrating with outer integument (Figure 10A, B).	Pericarp membranous: exocarp degenerated, mesocarp lacking, endocarp degenerated (Figure 10D).

ma cells (Figure 5E, G) or aerenchymatic (Figure 5F, H); vascular bundles arranged in a single ring-like whorl (Figure 5B), median and dorsal carpellary bundles separating from stele (Figure 5C, D), vascular bundles differentiating into dorsal carpellary bundle as well as median and commissural carpellary bundles (Figure 5E, G), or dorsal carpellary bundle absent or poorly defined (Figure 5F, H); funiculus ventral (Figures 5; 6); ovule bitegmic, outer integument (oi) consisting of outer epidermis (oeoi), mesophyll and inner epidermis (ieoi), inner integument consisting of palisade-like outer epidermis (oeii), mesophyll and tanniniferous inner epidermis (ieii) (Figures 5G, H; 6A, B), crassinucellate; embryo sac with 1 cell of functional macrospore (Figure 5G, H). *Ovary at median position*: ovule wall, integuments and nucellus remaining the same; embryo sac with 2 cells of functional macrospore (Figure 6A, B). *Ovary at apical position*: placental vascular bundles and funiculus strongly developed; ovule anatropous, position ventrally epitropous; obturator of elongate cells extending from base of style to micropyle (Figures 6C, D; 7A, B); outer integument horseshoe-shaped, opening close to funiculus facing placenta (Figures 6C; 7A, B); micropyle formed by inner integument, initially facing upwards (Figures 6C, D; 7A), but close to base of style, incurved towards placenta (Figure 7B). *Style* four-lobed or elliptic, styler channel well developed (Figure 7C, D), lined by conducting tissue; vascular bundles 4, 1 per lobe (Figure 7C) or inconspicuously arranged in a row along the long axis of elliptic style (Figure 7D; Table 6). *Stigma* reaching beyond hypanthium rim, penicillate, ramified into numerous simple papillae, dispersed between filament bases (Figure 8A–C). *Seed* exotegmic, outer integument undergoing atrophy; outer epidermis of inner integument (oeii) lengthening and becoming palisade-like, mesophyll consisting of 2 or 3 layers of parenchyma, inner epidermis of inner integument (ieii) tanniniferous (Figure 10A, B); tegmen black, lignified, still portraying palisade origin (Figure 10C, D); outer layer of nucellus ornate with cellulose thickenings, nucellus 3–5 cell layers thick; endosperm formation nuclear (Davis 1966), but later becoming cellular throughout (Figure 10D), absorbed by cotyledons containing no starch but copious amounts of oil.

Floral morphology at species level

Floral morphological characters and taxonomically important fruit characters are summarized in Table 7, and specialized hypanthium and sepal characters in Table 8. All these are associated with specific leaf anatomical characters (Brendenkamp & Van Wyk 2001).

DISCUSSION

Inflorescences

Weberling (1989) regards polytelic synflorescences as dominant within the Thymelaeaceae. He found monotelic synflorescences in the Gonystyloideae, a relatively primitive group, as well as certain genera of the Thymelaeoideae and Aquilarioideae. In the Gnidiaceae, it was found in *Lachmaea* L. (= *Cryptadenia* Meisn.) (Beyers & Van der Walt 1995; Beyers 1997), a genus endemic to the Cape Floristic Region (Beyers 1992). Weberling (1989) nevertheless concluded that it appears impossible to draw any taxonomic conclusions from the existence of monotelic synflorescences within these taxa. *Passerina* is characterized by polytelic synflorescences. Most species have multi-flowered main and co-florescences, and a reduction of florescences to single and subcapitulate spikes is clearly shown (Table 5).

Bracts

In their descriptions of the Thymelaeaceae, Domke (1934) reports the presence or absence of bracts and bracteoles, sometimes involucrel, and Peterson (1978) mentions that deciduous or persistent bracts are often present. In *Passerina*, single flowers are always enveloped by persistent bracts. In the present study, this constant taxonomic character has been employed in a key for application in herbarium and field work (Figures 3, 4; Table 5).

Floral morphology and anatomy at generic level

Receptacle

Historically the interpretation of the receptacle in the Thymelaeaceae has been controversial. Tables 1 and 2

TABLE 7.—Floral morphological and fruit characters in *Passerina*, correlated with leaf anatomy

Taxon	*Leaf structural type	Fruit		Floral envelope (hypanthium and sepals)						Ovary	Filaments		Anthers		
				Fleshy	Dry	Colour at pollination			Texture		Total length in mm	Anti-petalous in mm		Anti-sepalous in mm	
						green	yellow	yellow-pink	coriaceous						mem-branous
sp. nov. 1	A		X		X	X		X		5.3	1.7 × 0.5	0.4	1.2	0.5 × 0.3	
<i>ericoides</i>	B3	X		X			X			5.0	2.1 × 1.7	0.5	1.3	0.9 × 0.7	
<i>rigida</i>	B3, B6, D2	X			X			X		4.0	2.2 × 1.4	0.5	1.5	0.8 × 0.5	
<i>paleacea</i>	B2, B3, B4, D2		X		X			X		4.2	2.4 × 1.4	0.7	1.4	0.6 × 0.5	
sp. nov. 2	B3		X		X			X		4.6	1.8 × 0.5	0.4	1.2	0.7 × 0.3	
<i>galpinii</i>	B2, B3		X						X	5.3	2.0 × 1.1	1.4	2.1	0.6 × 0.5	
<i>glomerata</i> subsp. <i>glomerata</i>	B2, B3, B5		X			X		X	X	6.4	2.4 × 0.9	0.9	1.4	0.8 × 0.4	
<i>glomerata</i> subsp. nov.	B6		X			X		X	X	4.9	2.5 × 0.9	1.2	1.4	0.9 × 0.4	
<i>obtusifolia</i>	B2, B3, B4, B5		X			X		X	X	6.8	2.5 × 1.1	1.2	2.2	1.1 × 0.5	
<i>burchellii</i>	B1		X			X		X	X	4.7	1.6 × 0.6	0.7	1.5	0.5 × 0.3	
<i>pendula</i>	B2		X			X			X	6.5	2.0 × 0.7	1.5	2.0	0.8 × 0.4	
<i>comosa</i>	B2, B3, D1		X			X		X		7.3	2.7 × 1.0	0.7	1.5	0.7 × 0.4	
<i>pallidosa</i>	B2		X			X		X	X	7.2	2.3 × 1.0	1.2	2.4	0.7 × 0.5	
<i>montana</i>	B2, B3, D1		X			X		X	X	5.8	2.1 × 0.6	0.6	1.5	0.8 × 0.4	
sp. nov. 3	B3		X			X		X	X	5.9	1.6 × 1.0	1.1	2.2	0.7 × 0.2	
<i>drakensbergensis</i>	B3		X			X		X	X	5.9	2.4 × 0.9	1.2	2.0	0.9 × 0.3	
<i>nubra</i>	B4		X			X		X	X	8.4	2.7 × 1.1	0.7	1.7	0.9 × 0.3	
<i>filiformis</i> subsp. <i>filiformis</i>	B3, B4		X			X		X	X	6.0	2.3 × 0.5	1.1	2.2	0.8 × 0.3	
<i>filiformis</i> subsp. nov.	B6		X			X		X	X	6.5	2.5 × 0.6	1.2	2.2	0.8 × 0.3	
sp. nov. 4	C		X			X		X	X	6.6	2.2 × 0.7	0.8	1.7	0.8 × 0.3	
<i>falcifolia</i>	C		X			X		X	X	8.4	2.5 × 0.7	1.4	2.1	1.0 × 0.4	
<i>vulgaris</i>	D		X			X		X	X	6.2	2.1 × 1.1	0.7	1.4	0.9 × 0.4	

\* From Bredenkamp & Van Wyk (2001).  
X, character present.



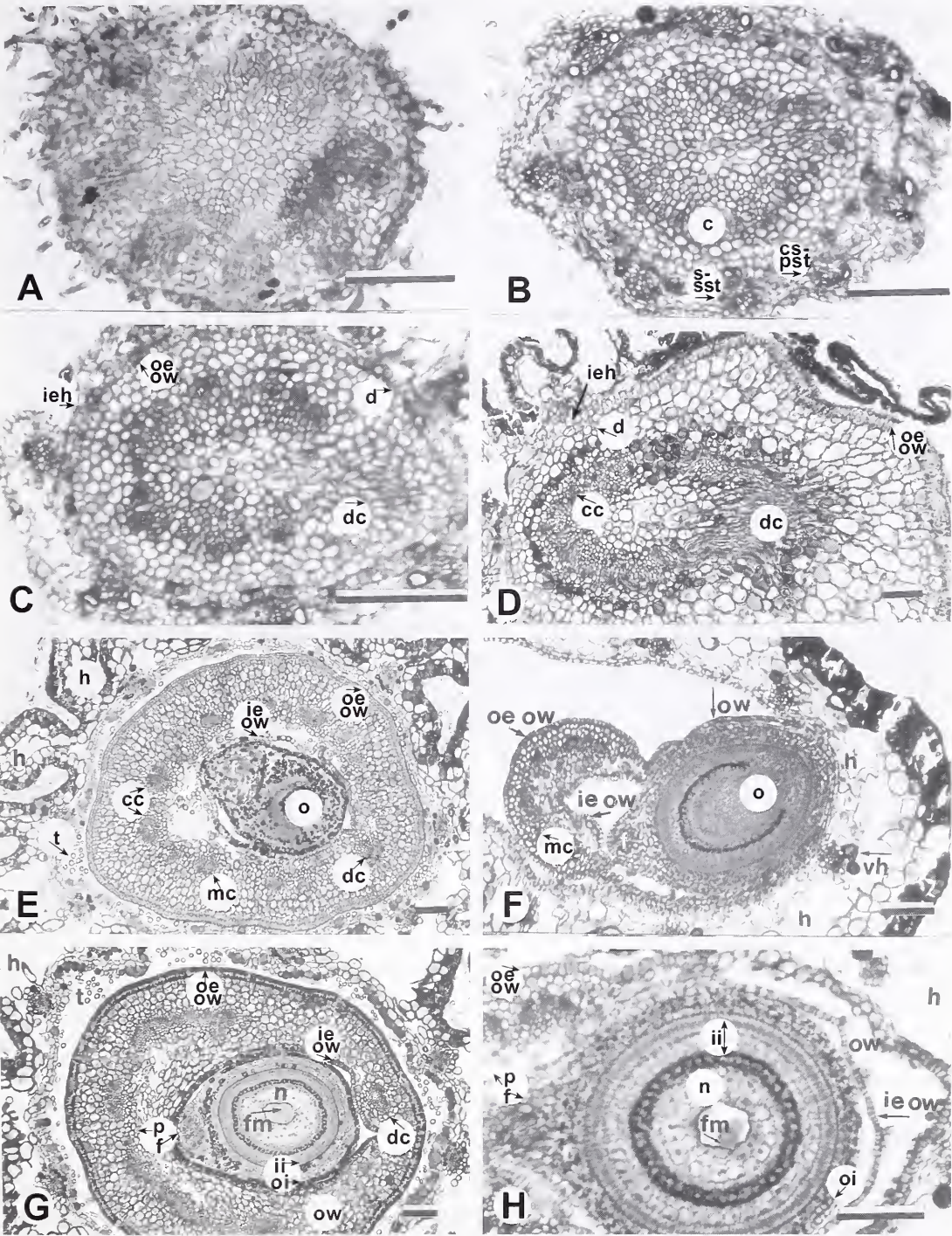


FIGURE 5.—LM photographs of *P. ericoides*, Bredenkamp 956, with fleshy fruit, and *P. vulgaris*, Bredenkamp 951, with dry fruit, showing structure of receptacle and base of ovary. A–D. *Us* at different levels of receptacle. A–C. *P. vulgaris*: A, departure of eight traces from central stele; B, carpelary bundles arranged in ring, fused stamen and sepal traces in peripheral position; C, differentiation of cortex tissue into inner epidermis of hypanthium and outer epidermis of ovary wall, separation of dorsal carpelary bundle. D, comparison to similar stage in *P. ericoides*. E–H, *Us* at base of ovary showing vasculature of ovary wall, funiculus and chalaza of pendulous ovule: E, *P. ericoides*, ovary wall independent of hypanthium, carpelary bundles in a single whorl; F, *P. vulgaris*, young bud, ovary wall loosely adhering to hypanthium distally; G, *P. ericoides*, one cell of functional macrospore; H, comparison to similar stage in *P. vulgaris*, reduction of dorsal carpelary bundle. c, carpelary bundle; cc, commissural carpelary bundles; cs-pst, fused commissural sepal and antipetalous stamen bundles; d, area of tissue differentiation; dc, dorsal carpelary bundle; f, funiculus; fm, functional macrospore; h, hypanthium; ieh, inner epidermis of hypanthium; ieow, inner epidermis of ovary wall; ii, inner integument; mc, median carpelary bundle; n, nucellus; o, ovule; oeow, outer epidermis of ovary wall; oi, outer integument; ow, ovary wall; p, placenta; s-sst, fused sepal midrib and antisepalous stamen bundle; t, trichome; vh, vascular bundle of hypanthium. Scale bars: A–H, 100  $\mu$ m.



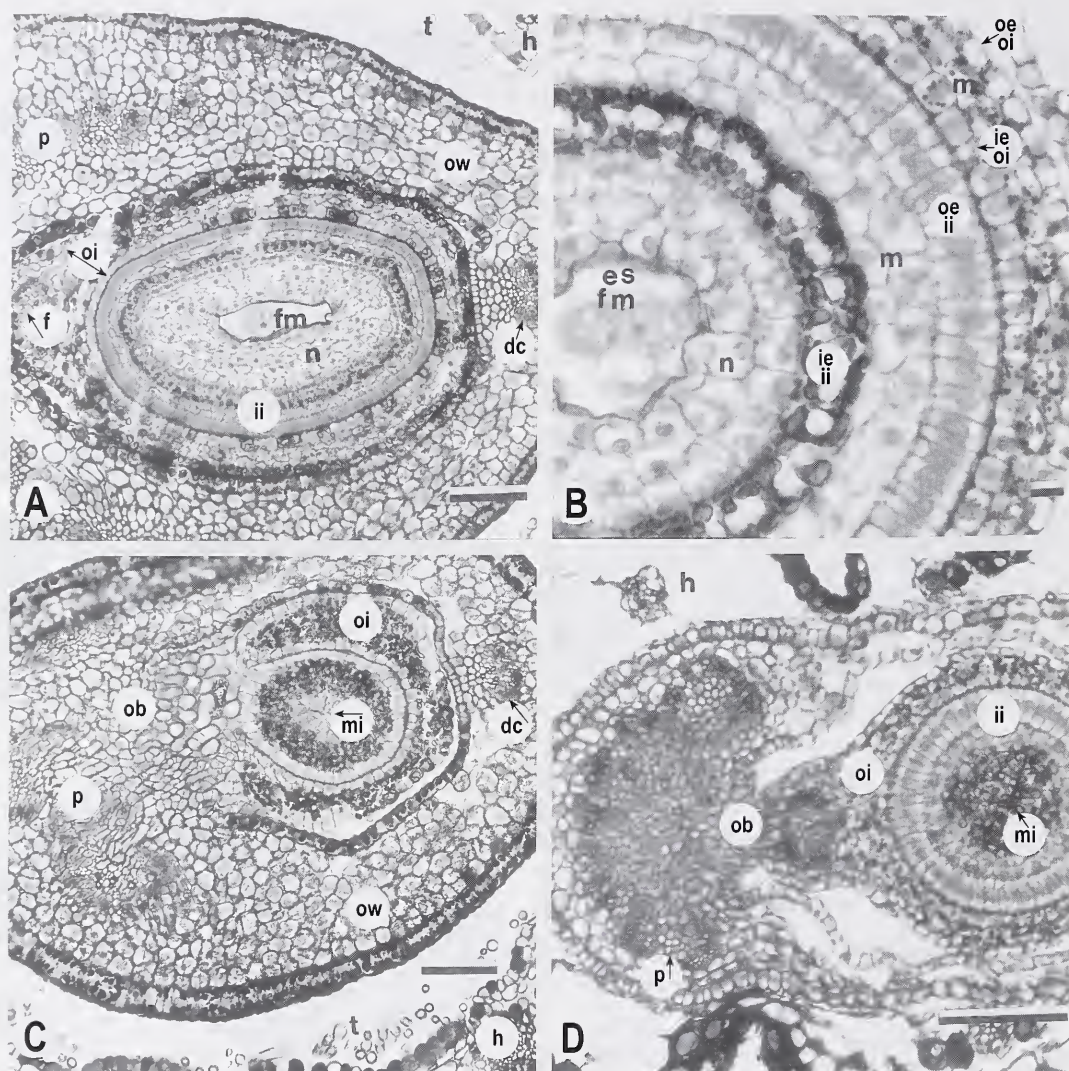


FIGURE 6.—LM photographs of *P. ericoides*, Bredenkamp 956, with fleshy fruit, and *P. vulgaris*, Bredenkamp 951, with dry fruit, showing structure of ovary and ovule. A, B, *ts* in median position of ovary: A, *P. ericoides*, embryo sac and two cells of functional megaspore; B, higher magnification of similar stage in *P. vulgaris*. C, D, *ts* at top of ovary. C, *P. ericoides*, placenta, obturator and micropyle originating from inner integument; D, comparison of similar stage in *P. vulgaris*. Abbreviations as in Figure 5. es, embryo sac; ieii, inner epidermis of inner integument; ieoi, inner epidermis of outer integument; m, mesophyll; mi, micropyle; ob, obturator; oeii, outer epidermis of inner integument; oeoi, outer epidermis of outer integument. Scale bars: B, 10  $\mu$ m; A, C, D, 100  $\mu$ m.

show that Meisner (1857) regards the floral envelope as perigynous and hypocateriform, implying a cup-shaped receptacle or hypanthium. Gilg (1891, 1894) describes the floral envelope as a cylindric receptacle which is articulate in the upper half, and Endlicher (1837, 1847), Leandri (1930) and Dahlgren & Thorne (1984) regard the floral arrangement as perigynous. The present study indicates that the receptacle (in *ts*) is very short (Figure 5A, B) and definitely not cup-shaped. This is evident from the arrangement of peripheral cortex cells in rows, followed by differentiation into the inner epidermis of the hypanthium and the outer epidermis of the ovary wall (Figure 5D), finally by the separation of the hypanthium (including the vascular bundles differentiated from the stele) from the ovary wall and the presence of trichomes in the space subsequently formed (Figure 5D–F).

#### *Hypanthium and androecial position*

Owing to reduction of the receptacle, the hypanthium in *Passerina* is here interpreted as being formed by the fused calyx and androecium only. The vascular tissue of the hypanthium constitutes the fused sepal and stamen traces (Heinig 1951), separating from the central stele in a single whorl and forming a peripheral ring of eight vascular bundles (Figure 5A, B), which persist throughout the length of the hypanthium. A similar pattern of fusion and distribution of vascular tissue has been reported by Heinig (1951) and for the genus *Lachnaea* (= *Cryptadenia*) by Beyers (1992) & Beyers & Van der Walt (1995). In *Passerina* the central stele differentiates into carpellary bundles after the separation of the fused sepal and stamen traces (Figure 5C–E). It can therefore be concluded that



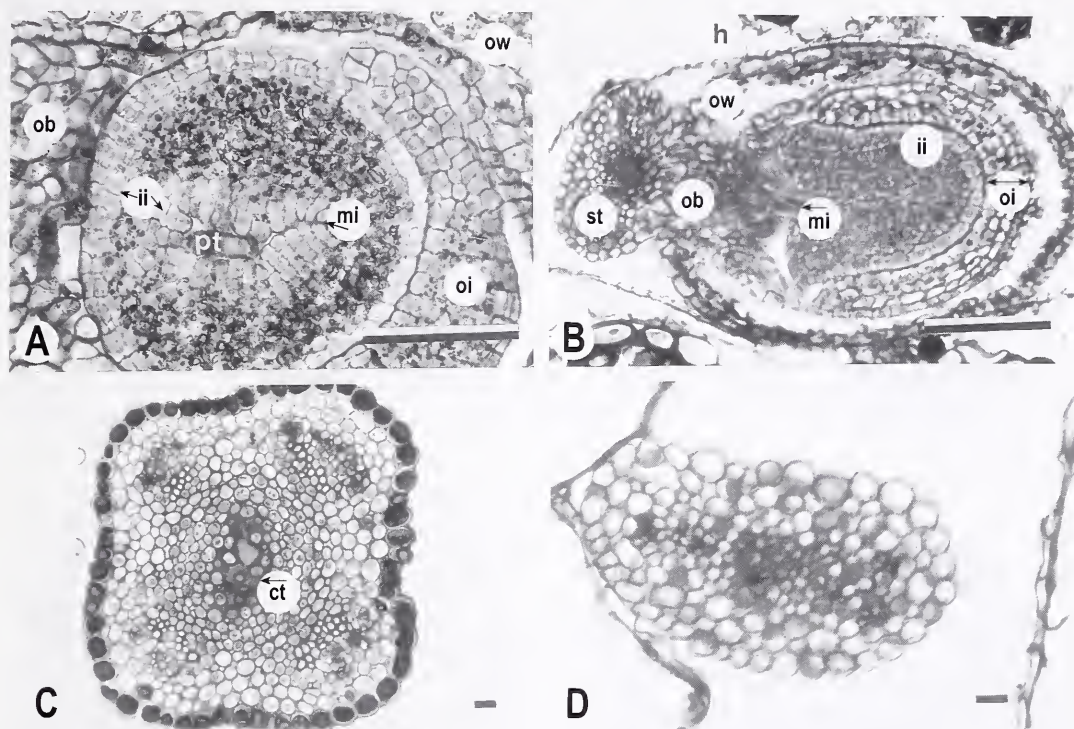


FIGURE 7.—LM photographs of *P. ericoides*, Bredenkamp 956, with fleshy fruit, and *P. vulgaris*, Bredenkamp 951, with dry fruit, showing structure of micropyle and style. A. *P. ericoides*, obturator, pollen tube penetrating micropyle, opening of outer integument towards micropyle. B. similar stage in *P. vulgaris*, style departing laterally. C, D, t/s of style. C, four-lobed style in *P. ericoides*. D, elliptic style in *P. vulgaris*. Abbreviations as in Figure 5. ct, conducting tissue; mi, micropyle; ob, obturator; pt, pollen tube; st, style. Scale bars: C, 10 µm; A, B, 100 µm.

the segments of the floral envelope and the androecium arise below the gynoecium, the floral arrangement being hypogynous and the ovary superior (Weberling 1989).

#### Identity of floral envelope

From Wikström (1818) to Takhtajan (1997) (Tables 1; 2) the floral envelope in Thymelaeaceae and, in many cases *Passerina*, was variously interpreted as an infundibular corolla, hypocateriform hypanthium, infundibular perigone, perianth, cylindric receptacle, floral tube formed by coalescence of four external whorls, perianth tube, or a hypanthium. Heinig (1951) supports the interpretation of Leandri (1930) and Domke (1934) of the floral tube as appendicular in origin, composed of the fused bases of the sepals and adherent stamen filaments, also pointing out that the sepal is with few exceptions a three-trace organ. Bunniger (1972) is of the opinion that the hypanthiums in families of the Myrtales and Thymelaeales have a similar origin. Our results show eight vascular bundles running along the length of the hypanthium and separating into sepal and stamen bundles, each sepal lobe eventually with three vascular bundles (Figure 8A, B). We regard the floral envelope as a hypanthium (fused calyx and androecium), differentiating into four petaloid sepals and a diplostemonous androecium, arising from the hypanthium rim at the separation of the sepals. A very short receptacle (Heinig 1951), which does not contribute to the hypanthium,

indicates a reduction in tissue and a possible advanced state. This is indeed the case in *Passerina*.

A study of petaloid scales in Thymelaeaceae has added further evidence to the interpretation of the floral envelope. These scales have been regarded by various authors as perigynous scales or glands, perigynous nectaries, petals or staminodes, petaloid scales and petaloid appendages (Tables 1; 2). Heinig (1951) is convinced that the morphology and vascularization of the petaloid scales resemble that of stipules, an opinion shared by Rao & Dahlgren (1969) on the floral anatomy and relationships of the Oliniaceae. In their floral description of *Olinia*, Dahlgren & Van Wyk (1988) consider the petaloid scales as true petals. Heinig (1951) concludes that the Thymelaeaceae are apetalous. In *Passerina* there are no petaloid scales or corolla (Tables 1; 2). Our results have shown the separation of antipetalous as well as antisepalous stamens, but petaloid scales or even vestiges of them were not observed. We therefore regard *Passerina* as truly apetalous. The complete reduction of the corolla or the absence of petaloid scales can be regarded as an advanced state in the Thymelaeaceae; it could also be interpreted as part of the anemophilous syndrome displayed by the genus. Based on both the pattern of the vascular tissue and the absence of petaloid scales, we consider the floral envelope in *Passerina* as a hypanthium consisting of the fused calyx and androecium, differentiating into four sepals and the diplostemonous stamens.

TABLE 8.—Specialized characters of the floral envelope in *Passerina*, correlated with leaf anatomy

Taxon	Leaf structural type	Fragmentation of hypanth. at neck base	Fragmentation of at circumf. of ovary	Hypanthium		Sepals									
				neck length*	indumentum at ovary	indumentum at neck	outer lobe surface		indumentum		inner lobe surface	inner lobe: l × w*	outer & inner	shape of lobes	
							adaxial	abaxial	adaxial	abaxial				outer	inner
sp. nov. 1 <i>verticoides</i>	A	X		1.2	tomentose	tomentose	glabrous	apex setose	glabrous	glabrous	glabrous	1.9 × 1.2	concave, widely ovate	cymbiform	widely ovate
	B3		X	0.6	strigose	strigose	puberulent	glabrous	puberulent	glabrous	glabrous	1.6 × 2.0			
<i>rigida</i>	B3, B6, D2		X	0.8	glabrous	tomentose	midrib tomentose	glabrous	tomentose	glabrous	glabrous	1.8 × 0.9	concave, elliptic or subtrilobed	cymbiform	obovate
	B2, B3, B4, D2		X	0.3	glabrous	glabrous	glabrous	glabrous	glabrous	glabrous	glabrous	1.8 × 1.5			
sp. nov. 2	B3		X	0.7	tomentose	tomentose	apex tomentose	apex setose	glabrous	glabrous	apex setose	1.8 × 1.0	concave, widely ovate	cymbiform	obovate
	B2, B3		X	1.0	pubescent	pubescent	glabrous	glabrous	apex margin tomentose	glabrous	glabrous	2.4 × 1.6			
<i>glomerata</i> subsp. <i>glomerata</i>	B2, B3, B5		X	0.8	glabrous	tomentose	scantly pubescent	glabrous	scantly pubescent	glabrous	glabrous	2.3 × 0.8	concave, widely ovate	cymbiform	oblong-elliptic
	B6		X	0.7	apex tomentose	tomentose	apex tomentose	glabrous	tomentose	glabrous	glabrous	2.6 × 1.6			
<i>obtusifolia</i>	B2, B3, B4, B5		X	1.8	glabrous	tomentose	tomentose	glabrous	tomentose	glabrous	glabrous	2.8 × 0.9	concave, widely ovate	cymbiform	narrowly oblong
	B1	X		0.8	glabrous	tomentose	midrib setose	apex setose	tomentose	apex setose	glabrous	2.3 × 0.6			
<i>burchellii</i>	B2	X		0.6	glabrous	tomentose	scantly tomentose	glabrous	scantly tomentose	glabrous	glabrous	2.9 × 1.5	concave, widely ovate	cymbiform	oblong
	B2	X		0.9	glabrous	tomentose	glabrous	tomentose	glabrous	tomentose	tomentose	2.8 × 1.0			
<i>conosa</i>	B2	X		2.6	shortly tomentose	strigose	glabrous	apex setose	glabrous	apex margin tomentose	apex setose	2.2 × 1.2	concave, widely ovate	cymbiform	oblong
	B2, B3, D1	X		1.3	glabrous	tomentose	scantly tomentose	glabrous	tomentose	glabrous	glabrous	2.1 × 1.0			
sp. nov. 3	B3	X		1.4	glabrous	scantly tomentose	glabrous	apex setose	glabrous	glabrous	apex tomentose	2.7 × 1.5	concave, lanceolate	cymbiform	obovate
	B3	X		1.7	scantly tomentose	tomentose	glabrous	tomentose	glabrous	tomentose	tomentose	2.4 × 0.8			
<i>drakensbergensis</i>	B4	X		2.0	glabrous	pubescent	glabrous	glabrous	glabrous	glabrous	glabrous	2.9 × 1.7	concave, lanceolate	cymbiform	obovate
	B3, B4	X		1.7	tomentose	tomentose	glabrous	apex setose	glabrous	apex setose	apex setose	2.2 × 1.4			
<i>rubra</i>	B6	X		1.5	scantly tomentose	tomentose	glabrous	apex setose	glabrous	glabrous	glabrous	2.5 × 1.5	concave, lanceolate	cymbiform	obovate
	C	X		2.3	upper half tomentose	tomentose	glabrous	apex setose	glabrous	glabrous	glabrous	2.1 × 1.3			
sp. nov. 4	C	X		3.0	scantly tomentose	tomentose	scantly tomentose	glabrous	tomentose	glabrous	glabrous	2.5 × 1.3	concave, lanceolate	cymbiform	obovate
	D2	X		1.6	glabrous	scantly tomentose	scantly tomentose	glabrous	glabrous	glabrous	glabrous	2.5 × 1.3			

X, character present, \* average in mm.



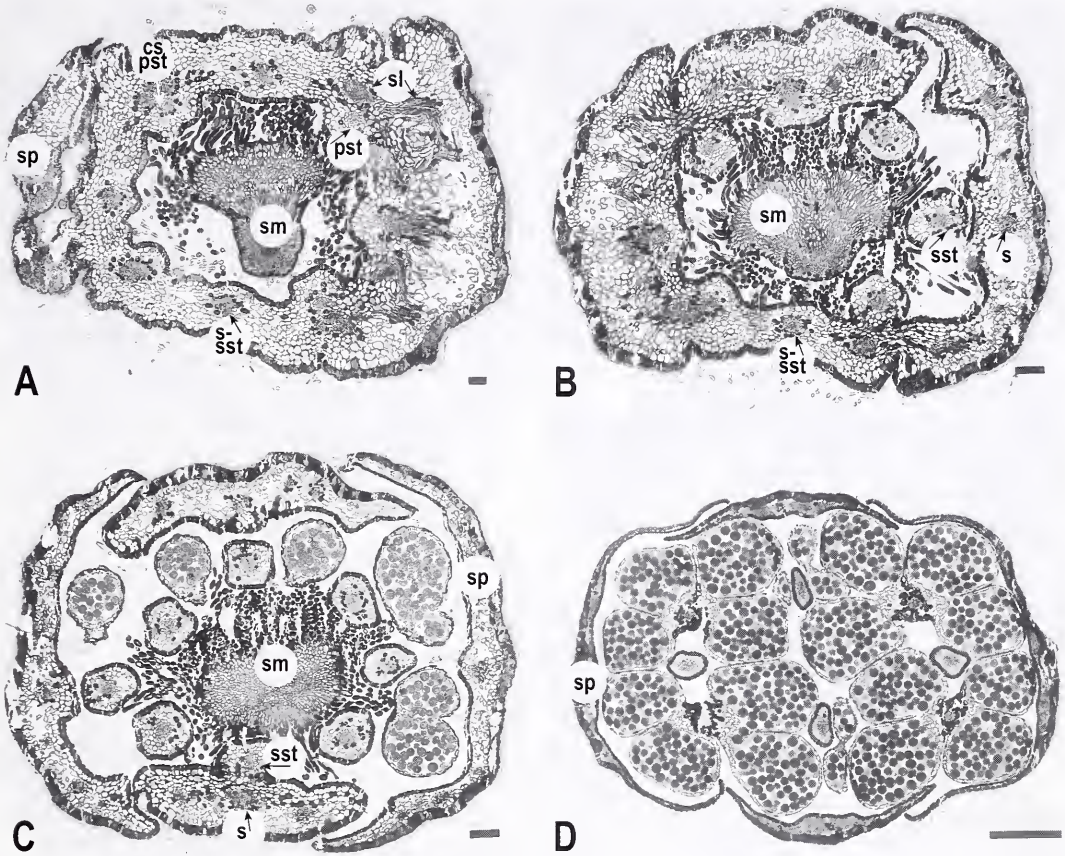


FIGURE 8.—LM photographs of *P. ericoides*, Bredenkamp 956, with fleshy fruit, and *P. vulgaris*, Bredenkamp 951, with dry fruit, showing structure of androecium. A–D, serial *ts*s of sepals and two anther whorls. A–C, *P. ericoides*: A, each of fused commissural sepal and antipetalous stamen bundles splitting into two sepal laterals and one antipetalous stamen bundle; B, fused sepal midrib and antisepalous stamen bundle, splitting into sepal midrib and antisepalous stamen bundle; C, final stage in separation of antisepalous stamen bundles. D, *P. vulgaris*, *ts*s through both anther whorls. Abbreviations as in Figure 5. pst, antipetalous stamen bundle; s, sepal midrib bundle; sl, sepal lateral bundle; sm, stigma; sp, sepal; sst, antisepalous stamen bundle. Scale bars: A–D, 100  $\mu$ m.

### Fragmentation of hypanthium

The fruit in *Passerina* is enveloped by a persistent, loosely attached hypanthium. Bentham & Hooker (1880), Gilg (1891, 1894), Domke (1934) and Melchior (1964) mention that the hypanthium is articulated above the ovary. We found no definite articulation point in the hypanthium neck (narrowed part of hypanthium between apex of ovary and sepals) in *Passerina*, possibly because of the absence of receptacle tissue and the appendicular nature of the hypanthium. The base of the neck fragmented as a result of desiccation and torsification of cells (Figure 2E). In some species, fragmentation of the hypanthium takes place over the widest circumference of the fruit, shedding the fragmented distal part of the hypanthium, sepals and androecium (Figure 1D). A strong association was found between flowers with a short hypanthium neck and fragmentation of the hypanthium over the widest part of the fruit, and also between flowers with a long hypanthium neck and fragmentation at the base of the neck (Table 8).

A plane of circumscession, dividing the floral tube into a basal and upper portion, is clearly illustrated in *Gnidia* and *Struthiola* (Peterson 1978) and *Lachnaea* (Beyers

1992; Beyers & Van der Walt 1995). We hypothesize that the plane of circumscession possibly indicates a difference in tissue composition between the basal and upper portions of the hypanthium and that this articulation can be of morphological importance in the Thymelaeaceae. The basal portion of the floral tube below the plane of circumscession possibly indicates the inclusion of receptacle tissue in the hypanthium, whereas the upper portion consists of calyx and androecium tissue only (accepting the apetalous state). An alternative interpretation, offered by one of the referees of this paper, regards the vasculature as a prerequisite to decide whether one is dealing with a hypanthium (appendicular in origin) or a receptacle (axial in origin). The significance of an articulation indicating a distinction between parts of the hypanthium of different derivation, should be further investigated.

### Androecium

In his description of Thymelaeaceae, Peterson (1978) describes the stamens as twice as many or as many as the sepals (rarely reduced to two or one), in one or two whorls, the outer whorl antisepalous. In the subfamily Aquilarioideae (Heinig 1951), stamens are of approximately



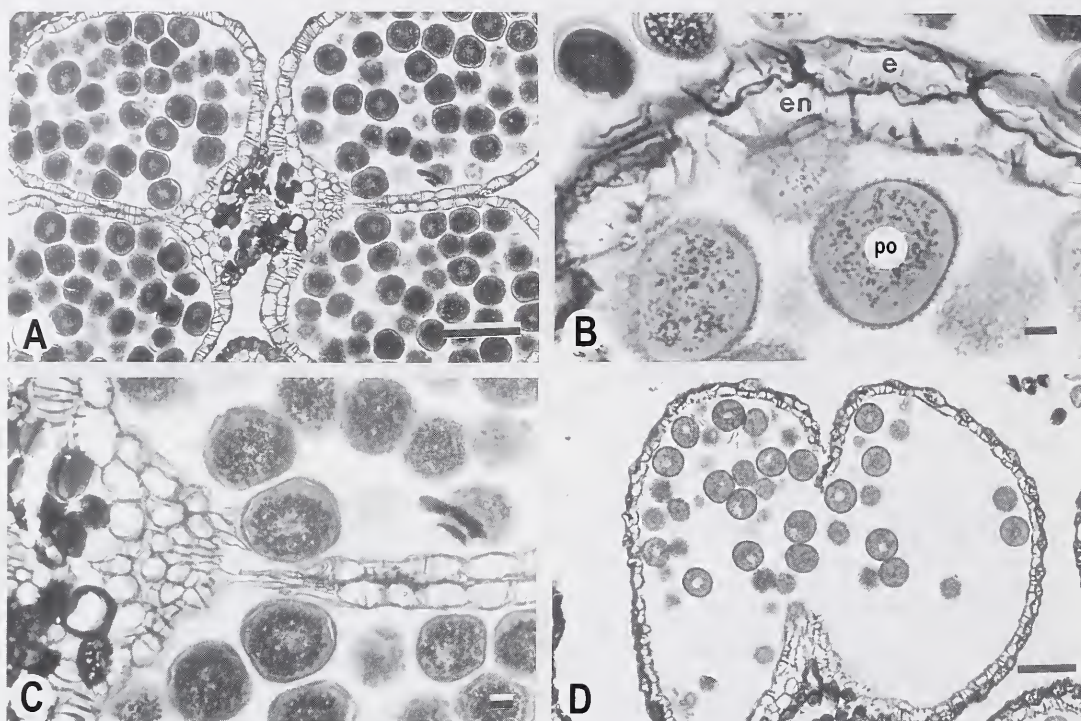


FIGURE 9.—LM photographs of *P. ericoides*, Bredenkamp 956 and *P. vulgaris*, Bredenkamp 951, showing structure of anther locules in t/s: A, *P. vulgaris*, 4-locular anther; B, *P. ericoides*, cell wall thickenings of endothecium rib-like; C, *P. vulgaris*, rupturing of partition between loculi; D, *P. ericoides*, rupturing of outer walls of thecae, extrorse. e, epidermis; en, endothecium; po, pollen. Scale bars: B, C, 10 µm; A, D, 100 µm.

equal length and the traces supplying them separate from the sepal traces, practically in a single whorl. The Thymelaeoideae is characterized by stamens arising as two distinct whorls at two distinct levels in the floral tube. The dimorphic diplostemonous nature of stamens in *Passerina* (Thymelaeoideae), in which the antipetalous stamens are shorter than the antisepalous ones, has been confirmed by our observations (Figure 8A–C). According to Heinig (1951) evolution within the androecium has been from polystemony to diplostemony to dimorphic diplostemony, indicating the advanced state of the androecium in *Passerina*. Peterson (1978) describes the anthers as usually introrse, rarely extrorse. Species of *Passerina* have large, exerted, extrorse anthers, clearly an adaptation to the anemophilous syndrome of the genus.

#### *Separation of fused sepal and stamen traces*

Heinig (1951) is of the opinion that a foreshortening of the floral axis has resulted in a fusion of the calyx and androecium and that progressive stages of adnation can be observed in the family. In all species the antipetalous stamen traces are fused to the commissural sepal traces and the antisepalous stamen traces to the sepal midrib traces at their point of origin from the stele. In the Aquilarioideae, in *Octolepis dinklgei*, they become separated in the receptacle or, in other cases, low down in the floral tube. Except for *Gnidia splendens* (= *Lasiosiphon splendens*), in which the separation of the antipetalous and antisepalous stamen traces takes place in the receptacle, Thymelaeoideae is characterized by

separation higher up in the floral tube, e.g. at the top of the ovary in *Dirca occidentalis* and below the origin of the sepals in *Gnidia subulata* (Heinig 1951). In *Passerina* the separation of the antipetalous stamen traces takes place at the origin of the sepals (Figure 8A, B) and separation of the antisepalous traces slightly higher up (Figure 8C), indicating what appears to be a phylogenetically advanced tendency.

#### *Pollen*

Pollen grains of most members of Thymelaeaceae are monads, spheroid and pantoporate, characterized by a typical croton pattern, comprising rings of more or less trihedral sexine units mounted on an underlying reticulum of circular muri (Bredenkamp & Van Wyk 1996). In *Passerina*, the basal reticulum, as in the typical croton pattern, is no longer discernible as it is replaced by a secondary reticulum derived from fused sexine. The supratracteal subunits are fused completely to form a continuous reticulum which replaces the underlying reticulum. The reticulum in *Passerina* is therefore secondary in origin and considered phylogenetically advanced. This modification of the crotonoid pattern is probably also of functional significance as pollen in *Passerina* is adapted to anemophily.

#### *Disc*

In Aquilarioideae a hypogynous disc is generally absent, but is almost always present in Thymelaeoideae

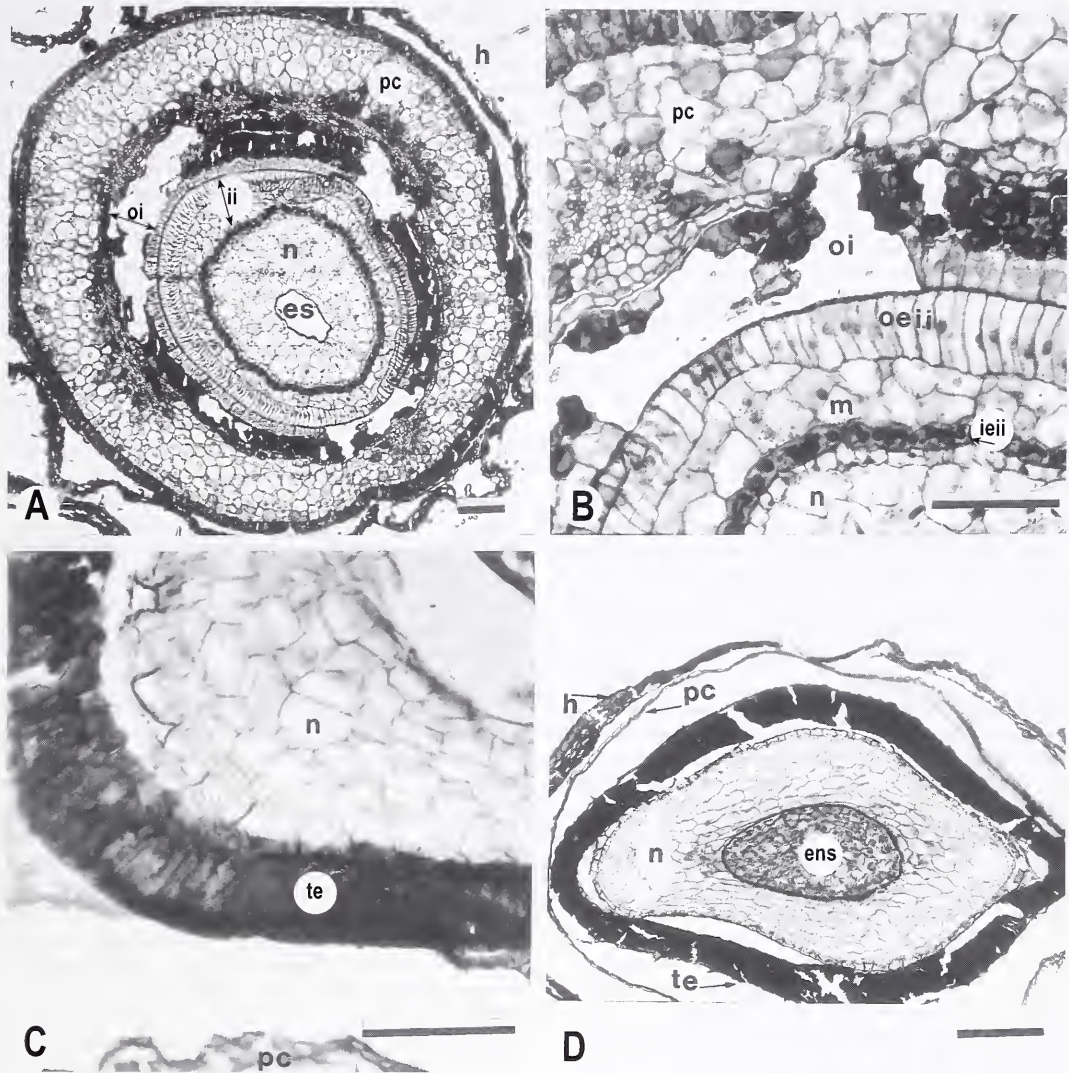


FIGURE 10.—LM photographs of *P. ericoides*, Bredenkamp 956, with fleshy fruit, and *P. vulgaris*, Bredenkamp 951, with dry fruit, showing structure of young fruit and developing seed in *t/s*. A, B, *P. ericoides*: A, pericarp fleshy, atrophy of outer integument; B, higher magnification, outer epidermis of inner integument palisade-like, mesophyll, inner epidermis of inner integument tanniferous. C, D, *P. vulgaris*: C, palisade-like exotegmen discernable in tegmen. D, tegmen black and lignified, crassinucellate, endosperm initially nuclear. Abbreviations as in Figure 5. ens, endosperm; es, embryo sac; ieii, inner epidermis of inner integument; m, mesophyll; oeii, outer epidermis of inner integument; pc, pericarp; te, tegmen. Scale bars: A–D, 100  $\mu$ m.

(Heinig 1951; Peterson 1978). Possibly because of a reduction of tissue, no disc was observed in *Passerina*, a state confirmed by Bunniger (1972).

Ovary

The ovary in *Passerina* was described as unilocular up to the time of Domke (1934) (Table 1). The pseudomonomerous state is mentioned by Eckardt (1937), Melchior (1964), Dahlgren & Thorne (1984) and Cronquist (1988) (Table 2), while most authors agree that ovules are solitary and pendulous. According to Takhtajan (1997) the ovary in Thymelaeoideae consists of two carpels, it is monolocular and the ovule is solitary. Heinig (1951) is convinced that within the carpellary

whorl a reduction series may be observed, ranging from four- or more-carpellate members in the Aquilarioideae to the two-carpellate members of the Thymelaeoideae in which one carpel is markedly contracted, thus a pseudomonomerous ovary. According to Heinig (1951) the ovules have been reduced to one per locule in the entire family. In *Passerina*, at the base of the ovary, the dorsal and median carpellary bundles initially separate from the central stele (Figure 5C, D). After differentiation has taken place, the dorsal, median and commissural carpellary bundles (Figure 5E) can be distinguished. Because of a redistribution of carpellary bundles, the single dorsal carpellary bundle is arranged at the opposite side of the horseshoe-shaped median and commissural carpellary bundles (Figure 5G). In *Dirca palustris*,



Heinig (1951) has illustrated the authenticity of the pseudomonomerous ovary by the presence of two dorsal carpellary bundles, one in the fertile carpel and one in the second, reduced, sterile carpel positioned between two groups of commissural carpellary bundles. Bunniger (1972) showed the presence of two carpels in the flower primordia of *P. filiformis*. In the present study, which included the young bud stage of *P. vulgaris* (Figure 5F), no indication of a second carpel or a second dorsal carpellary bundle was found, possibly because of reduction and fusion processes, which had already taken place in the formation of the young ovary, consequently we consider the ovary of *Passerina* as pseudomonomerous.

#### Ovule type and position

Domke (1934) describes the ovule in Thymelaeaceae as pendulous, anatropous, with a ventral funiculus, exceptionally hemi-anatropous or orthotropous, indicating a phylogenetic tendency. Our study clearly indicates a pendulous, anatropous ovule in *Passerina* (Figure 6C, D). The funiculus is ventral and has been sectioned from the base of the ovule (Figures 5E–H; 6A) to the point of attachment with the placenta (Figure 6C, D). Close to the embryo sac the micropyle is a trilete opening formed by the inner integument (Figures 6C, D; 7A), facing upward. Towards the micropyle, the outer and inner integuments become horseshoe-shaped (in *t/s*), resulting in the micropyle being directed towards the elongated obturator cells, located at the base of the style (Figure 7B). Based on these results, we agree with Dahlgren (1975b), who regards the ovule as pendulous and epitropous.

#### Obturator

Davis (1966) defines an obturator as any structure associated with directing the growing pollen tube towards the micropyle, but elongated cells extending from the base of the style to the micropyle are considered exclusive to the Thymelaeaceae. In *Passerina* such elongated obturator cells can be clearly seen at the level of the placenta, at the departure of the funiculus, touching on the inner integument (Figures 6C; 7A) and finally these cells extend from the base of the style entering the micropyle (Figure 7B).

#### Fruit

Most authors (Tables 1; 2) agree that the fruit in Thymelaeaceae is indehiscent. In *Passerina*, Wikström (1818), Meisner (1857) and Endlicher (1837, 1847) consider the fruit as a nut or a nutlet. Domke (1934) concludes that the fruit of *Dais*, *Gnidia*, *Lacluaea* (= *Cryptadenia*) and many taxa of *Passerina* can be defined as an achene, and that of *P. ericoides* as a berry. Dahlgren (1975b) considers the fruit of Thymelaeaceae as a nut or drupe, Peterson (1978) regards it as a berry, a nut, a drupe or a loculicidal capsule and Takhtajan (1997) describes them as nut-like, baccate or drupaceous. A relevant family character, that the outer integument of the ovule disintegrates and the inner integument becomes palisade-like and hardens to form a seed coat or tegmen (Figure 10A–D), is illustrated by the present study. Structurally the dry, membranous fruit in *Passerina* conforms to an achene (Spuyt 1994) and the reduction in pericarp tissue can probably be considered as

a specialized adaptation. A reduction in tissue from a drupe to a membranous 1-seeded berry or an achene can be illustrated in Thymelaeaceae and therefore the fruit in *Passerina* could be considered advanced within the family. We agree with Domke (1934) that *P. ericoides* (Figures 1F; 10A) and *P. rigida* are characterized by a fleshy 1-seeded berry, while all the other species have an achene (Figure 2F; Table 7). The achene remains enveloped in the remnants of the papyraceous hypanthium, nestled adaxially in the tomentum of the concave, persistent cymbiform bracts.

#### Seed

The existing confusion concerning the state of the tegmen in *Passerina* is a reflection of the total lack of information of this aspect in descriptions of the group by various authors (Tables 1; 2). Meisner (1857) describes a crustaceous pericarp and Domke (1934) a black, crustaceous testa. The ovule in *Passerina* is bitegmic (Figures 6; 7; 10). Corner (1976) refers to outer integument (oi) and inner integument (ii), the product of the outer integument becoming the testa and that of the inner integument, the tegmen. In *Passerina* the outer integument disintegrates, whereas the inner integument remains (Figure 10A), its outer epidermis becoming palisade-like (Figure 10A, B). Hence, the seeds of *Passerina* are exotegmic with a palisade, a state common to the family (Corner 1976). In *Passerina* the tegmen is black and lignified, and in *t/s*, still portraying its origin from the palisade-like epidermis (Figure 10C, D).

#### Floral and fruit morphology at species level (Tables 7; 8)

In the present study, specific results in leaf anatomy indicating the arrangement of taxa in *Passerina* (Brendenkamp & Van Wyk 2001), are associated with floral morphological structures as well as fruit and seed types. In Table 7, leaf structural types A and especially B3 are associated with four species that have smaller, yellow, membranous flowers (up to 5.3 mm long). Leaf structural types B4, B5, B6, C and D are associated with most species having larger, yellow-pink, papyraceous flowers (up to 8.4 mm long). The same tendency in the length of the neck, and the size of the inner sepals is shown in Table 8.

#### Fruit

Fleshy fruit in *P. ericoides* (Figure 1D, F) and *P. rigida* is possibly correlated with the moist maritime climate of the coastal habitat of these species; it is possibly also an adaptation to bird dispersal. Both species occur in the Western Cape, and the range of *P. rigida* extends along the coast to St Lucia. *P. ericoides* has red berries and *P. rigida* has yellow berries. All other species are characterized by achenes and are adapted to drier habitats, from mountainous areas along the Great Escarpment to the arid Karoo. In *Passerina*, each achene is enveloped by papyraceous remnants of the fragmented hypanthium and enclosed within the tomentum of an enlarged bract (Figure 2D, E), which often takes on a rounded shape and turns yellow, red or brownish.

The fruits of *Passerina* clearly illustrate the phenomenon of transfer of function from protection to dispersal

(Stebbins 1974). In *P. ericoides* and *P. rigida*, with fleshy fruit, the pericarp has the double function of protecting the ovules during early stages of development and dispersal. The mature fruit enlarges beyond the bracts and is protected by the coriaceous pericarp, while the patent bract does not have a protective function (Figure 1D). The pericarp of the fruit is yellow or red when it is ready for dispersal, probably by birds or small mammals (Richards 1986), and the dispersal unit is the berry. In all other species which are characterized by achenes, the protection of the ovule is apparently transferred from the pericarp to the persistent bract. The bract enlarges around the achene, protecting it in the woolly tomentum of the concave adaxial surface (Figure 2D). The mature fruit is often still enveloped by the reddish, papyraceous remnants of the hypanthium. Both *P. montana* and *P. glomerata* are characterized by subcapitulate inflorescences, with proliferating growth more common in the latter species. In *P. glomerata* (growing in the arid Karoo) the accompanying bract turns yellow and becomes more patent when the fruit is mature; the achene is shed after abscission. The yellow colour is associated with senescence of the bracts and these structures are eventually shed, leaving conspicuous bract scars on the remaining, often terminal, woolly inflorescence axis. The unit of dispersal, in this case, is the achene, assisted by the patent senescing bract. The achene falls to the ground where it could either be dispersed by ants or small mammals or germinate under favourable conditions. In *P. montana* (growing along the Great Escarpment), the margin of the fruiting bract turns red and it becomes more patent, exposing the achene enveloped in the beak-like, reddish, papyraceous hypanthium, which fragments at the neck base. Perhaps birds, attracted by the red colour (Richards 1986), feed on the exposed achenes. Leafless, terminal, woolly branchlets, with terminal scars are a conspicuous feature of the plant after fruiting and it therefore also seems possible that the subterminal capitulum with several achenes is broken off as a unit. In this case the dispersal unit could be the achene or the achene accompanied by the bract or perhaps even the entire subcapitulum. There is a need for further observations on seed dispersal in the field to test some of these suggestions.

#### Filament length

For a comparison of filament length, it is easier to measure the antisealous filaments as they are  $\pm$  twice the length of the antipetalous ones. Both *P. sp. nov. 1* and *P. sp. nov. 2* have short antisealous filaments of  $\pm$  1.2 mm, corresponding to their small flowers. *P. paludosa*, *P. filiformis* and *P. falcifolia* have exerted stamens because of their long (2.1–2.4 mm) filaments.

#### Anthers

Conspicuous differences in anther size have been noticed among the species; this has also been reported by Thoday (1924). In relation to flower size, most species have large exerted anthers between  $0.7(-0.9) \times 0.3(-0.7)$  mm, possibly an anemophilous adaptation. *P. ericoides* has  $\pm$  elliptic anthers (Figure 1), whereas those of *P. drakensbergensis* are narrowly oblong,  $0.9 \times 0.3$  mm. The largest anthers of  $1.0 \times 0.5$  mm are found in *P. obtusifolia* and *P. falcifolia*.

#### Floral envelope

The hypanthium and sepals in *P. ericoides* are characterized by their coriaceous (almost fleshy) appearance and dull green to pinkish colour. The floral envelope in *P. rigida*, *P. paleacea*, *P. sp. nov. 1* and *P. sp. nov. 2* is pale yellowish and quite membranous. *P. pendula* is distinguished by a pinkish floral envelope, with a membranous texture. In all the other species the floral envelope is yellow-pink at anthesis, with a papyraceous texture. After pollination these flowers turn red and the hypanthium and sepals become thinly papyraceous and dry.

For practical purposes the total length of the floral envelope indicates flower size, and its taxonomic importance is clearly illustrated by the general increase in size from species 1–20 (Table 7). *P. rigida*, *P. paleacea* and *P. sp. nov. 2* are characterized by small flowers, the length of the floral envelope 4.0–4.6 mm. In most other species it ranges from 5.3–7.3 mm long. *P. rubra* and *P. falcifolia* are characterized by large flowers, the floral envelope being 8.4 mm long.

#### Specialized characters (Table 8)

##### a. Fragmentation of hypanthium after fruiting

During the fruiting phase, the persistent hypanthium fragments over the broadest part of the ovary, in eight of the 20 species. Except in *P. obtusifolia*, the hypanthium of all these species is characterized by a short neck of 0.3–1.0 mm. Anatomically their leaves also correlate with leaf structural type B (Bredenkamp & Van Wyk 2001). When fragmentation occurs at the neck base, the hypanthium usually has a long neck length of mostly 1.3–3.0 mm, and such species are associated with leaf structural types A, B, C and D.

##### b. Indumentum of hypanthium

In certain species of the genus *Lachnaea* (Beyers 1992; Beyers & Van der Walt 1995), different trichome types are found below and above the articulation plane in the hypanthium. This state could possibly also be present in other genera of the Thymelaeaceae. In *Passerina* the trichome type remains constant over the length of the hypanthium, possibly because there is no articulation plane in the hypanthium. As *Passerina* is distributed over a wide range of habitats, the density of the indumentum has been important in the distinction of certain species (Table 8). *P. ericoides* is distinguished by the strigose indumentum over the length of the hypanthium, whereas the indumentum of the neck is strigose in *P. paludosa*. A completely glabrous hypanthium is characteristic of *P. paleacea*. In 12 of the species, the hypanthium surrounding the ovary is glabrous, scantily tomentose or tomentose at the apex, with the neck scantily tomentose or tomentose. In *P. sp. nov. 1*, *P. sp. nov. 2* and *P. filiformis* subsp. *filiformis* the hypanthium is tomentose over its entire length. In *P. galpinii* the whole of the hypanthium is pubescent, whereas in *P. rubra* only the neck is pubescent and the rest of the hypanthium is glabrous.

A strong correlation was found between the indumentum of the lower hypanthium and of the bract. There is a



tendency for species characterized by a glabrous hypanthium base (Table 8) to have a protective bract with a very hairy adaxial surface (Table 5), whereas species with a hairy hypanthium base have a less hairy to almost glabrous adaxial bract surface. When the hypanthium neck is not covered by a bract, it tends to be hairy in varying degrees. Only *P. paleacea* has a completely glabrous hypanthium. In this species the entire hypanthium is completely covered by the hairy adaxial surface of the bract because of the very short hypanthium neck. This tendency shows that the function of protection of the ovule is partly transferred from the hypanthium to the hairy bract (Stebbins 1974).

#### c. Indumentum of sepals

Thoday (1924) uses the character 'outer sepals bearded behind the apex' in his key to distinguish between species. The abaxial surfaces of the outer and inner lobes of seven species are setose at the apex only and the adaxial surfaces range from glabrous to variously hairy (Table 8). In *P. comosa* abaxial surfaces of both outer and inner lobes are tomentose and adaxial surfaces are glabrous, *P. drakensbergensis* is similar except for the tomentose adaxial surface of the inner lobes. All sepals are completely glabrous in *P. paleacea*. The indumentum of the sepals varies infraspecifically and should, however, be used with discretion to distinguish between groups of species.

#### d. Size and shape of sepals

The size of the inner sepals is of taxonomic importance (Table 8). *P. sp. nov. 1*, *P. ericoides*, *P. rigida*, *P. paleacea* and *P. sp. nov. 2* are characterized by shorter and broader inner sepals, varying from widely ovate, obovate, widely obovate to subrotund. All other species have longer, narrower inner sepals, the shape varying, with one exception, from narrowly oblong, oblong, oblong-elliptic, elliptic, to obovate. *P. drakensbergensis* is distinguished by lanceolate sepals arranged in the shape of a cross.

### Less important taxonomic characters

Ovary size (Table 7) has been considered less important, as it is difficult to measure all ovaries at the same developmental phase. In *Passerina* the size of the ovary increases markedly after anthesis and the enlarged ovary, enveloped by the persistent hypanthium, can already be observed in older flowers, rapidly followed by maturation of the fruit.

### Taxonomic relationships

Up to 1930, priority was given to the definition of subordinal or subfamilial taxa in Thymelaeaceae, based mainly on floral morphology (Table 1). Applying both morphological and anatomical evidence, Domke (1934) proposed a satisfactory subfamilial classification system and envisages a phylogenetic relationship between the Thymelaeaceae, Malvaceae and Euphorbiaceae. Modern techniques have enabled taxonomists to find relationships between families and to arrange them into higher hierarchies, with ranks such as superorders or subclass-

es. Thus Dahlgren (1980) placed the Thymelaeaceae in the superorder Malviflorae (= Dilleniiflorae), Cronquist (1981, 1988) placed it in the subclass Rosidae, Thorne (1992a, 1992b) in the superorder Malvanae and Takhtajan (1997) in the subclass Dilleniidae (Table 2).

Heinig (1951) discussed the relationships of the Thymelaeaceae with the Myrtales, Saxifragaceae, Lythraceae, Gonystylaceae and Malvales on the basis of floral morphology and concluded that a polyphyletic origin of the Thymelaeaceae could be sought in both the Flacourtiaceae and Tiliaceae.

Cronquist (1968, 1981, 1988) considered the Thymelaeaceae as completely at home in the Myrtales (Rosidae) on account of the strongly perigynous polypetalous to apetalous flowers, internal phloem, vested pits and obturator. However, he admitted a possible relationship with other families, based on the pseudomonocarpous ovary and crotonoid pollen. Dahlgren (1975a, b) placed the superorder Thymelaeanae between the Dilleniaceae (Dilleniales, Cistales, Malvales, Urticales, Euphorbiales) and the Myrtaceae. Within the superorder Malviflorae, Dahlgren (1980) recognized a close affinity between the Malvales and Euphorbiales, and indicated a strong relationship with the Urticales and the Thymelaeales, but a phylogenetic affinity between the Malviflorae and Myrtiflorae was not supported. The inclusion of the Thymelaeaceae in the Myrtales was reviewed by Dahlgren & Thorne (1984). They argued that anatomically, most members of the family possess Myrtalean characters. On the other hand, embryological, chemical and palynological evidence strongly indicates an affinity with the Malviflorae. Thorne (1992a) accepted the superorder Malvanae, but included the Thymelaeaceae in the order Euphorbiales. Takhtajan (1969) considered the Thymelaeales to have a common origin with the Euphorbiales and Malvales, all arising from a Flacourtiaceae-type ancestor, and Takhtajan (1997) placed the Thymelaeales in the superorder Euphorbianae, with the Gonystylaceae as the only other family in the order.

Palynological evidence indicates that the very distinctive pollen in Thymelaeaceae is totally different from that of any Myrtales and similar to that of most Euphorbiaceae. Archangelsky (1971) concluded that both the Euphorbiales and the Thymelaeales belong to the subclass Dilleniidae and originated from ancestral lines of the Dilleniaceae → Violales → Malvales. In a paper on palynology of *Passerina*, Bredenkamp & Van Wyk (1996) supported Dahlgren (1980) in placing the Thymelaeales in the Malviflorae (= Dilleniiflorae).

In *Passerina*, the structure of the integuments surrounding the ovule provides taxonomically useful embryological evidence. We have shown the disintegration of the outer integument and the differentiation of the inner integument into a palisade-like outer epidermis, a mesophyll layer and an inner epidermis (Figure 10A, B). It is also clear that the mechanical part of the seed coat is derived from the palisade-like outer epidermis, hence it is an exotegmen (Figure 10C, D). Corner (1976) distinguished the Euphorbiales-Malvales-Thymelaeales-Tiliales (Malvalcan complex) on the basis of the exo-



tegmic palisade. He dismissed the derivation of the Malvacean complex from the Dilleniales (endotestal seeds) or Violales and looked towards the Myristicaceae (Magnoliales–Ranales) for the origin of the Malvacean seed.

Recent evidence from molecular phylogeny (Table 3) should be interpreted in context with the evidence from other botanical fields. The primary focus of The Angiosperm Phylogeny Group (APG 1998) is on orders, with a secondary focus on families of flowering plants. Above the ordinal level, ranks are defined as subgroups, clades or supraordinal subgroups. Magallón *et al.* (1999) attempted to compare these groups to the existing systems mentioned in the preceding paragraphs. Both APG (1998) and Magallón *et al.* (1999) recognized the Eudicots, a group characterized by tricolpate pollen, as well as the supraordinal group Core Eudicots, supported by pentamerous and isomerous flowers. Thymelaeaceae is designated to the Rosid clade by most authors. APG (1998) placed the Thymelaeaceae in the subgroup Eurosids II and order Malvales, whereas all the other authors placed it in the Expanded Malvales. The Malvacean relationship of the Thymelaeaceae seems to be strongly supported by molecular phylogeny, as well as floral morphology, anatomy, embryology and palynology.

The Euphorbiales–Malvales–Thymelaeales relationship indicated by embryology and palynology is, however, not supported by molecular data. APG (1998) placed the Euphorbiaceae in the order Malpighiales in the subgroup Eurosids I and Magallón *et al.* (1999) placed it in the Core Rosid Clade. Cronquist (1968, 1981, 1988) was convinced that if the Thymelaeaceae is not placed in the Myrtales, it would stand next to it. Conti *et al.* (1996), APG (1998), and Alverson *et al.* (1999) all regarded the Myrtales as a sister group of the Malvales or the Expanded Malvales to which the Thymelaeaceae is designated.

### Speculations on phylogeny

Within Thymelaeaceae, both Domke (1934) and Heinig (1951) agreed that the subfamily Thymelaeoideae is phylogenetically more advanced than the Aquilarioideae. On the basis of the advanced pollen, Bredenkamp & Van Wyk (1996) raised the subtribe Passerininae to the tribe Passerineae, a decision supported by the present study. Although many of the following advanced character states are present in other genera of the Thymelaeoideae, these advanced character states are all found together in *Passerina*: receptacle reduced to a  $\pm$  lenticular structure; departure of the fused sepal and stamen bundles before carpellary bundles; hypogynous floral arrangement; petal-like floral envelope comprising a hypanthium (fused calyx and androecium), differentiating into four sepals and a diplostemonous androecium; separation of stamen bundles high up in hypanthium, at formation of sepals; exserted, extrorse anthers; anemophilous habit; secondary reticulum of pollen; complete absence of petals or petaloid scales; asymmetric development of the style; superior, pseudomonomerous, unilocular ovary; asymmetric attachment of ovule at top of ovary; ventrally epitropous ovule; distinctive obturator; bitegmic ovule with exotegmic palisade; fruit a 1-seeded berry or an achene; seed with lignified, black exotegmen.

Considering all the characters mentioned, *Passerina* is considered highly advanced in relation to other genera in Thymelaeoideae.

### Systematic value

#### Family level

The exotegmic palisade and the distinctive obturator are regarded as family characters. They form the basis of Corner's (1976) Euphorbiales–Malvales–Thymelaeales–Tiliales complex.

#### Subfamily level

The Thymelaeoideae is distinguished on the basis of the calyx tube (hypanthium in the present study), diplostemonous androecium and pseudomonomerous ovary (Domke 1934; Heinig 1951).

#### Tribal level

On the basis of the secondary reticulum, unique to the pollen of *Passerina*, Bredenkamp & Van Wyk (1996) raised the subtribe Passerininae to the tribe Passerineae.

#### Genus level

The present study indicates the exserted, extrorse anthers and the anemophilous habit as unique to *Passerina*.

#### Species level

Characters useful at species level are summarized in Tables 7 and 8.

### CONCLUSIONS

The evidence on floral morphology not only confirmed the identity of 20 species and four subspecies, but also proved significant in the taxonomy of the genus. The status of the following taxa is confirmed by the present floral morphological study: *P. burchellii* Thoday, *P. comosa* C.H.Wright, *P. drakensbergensis* Hilliard & B.L.Burt, *P. ericoides* L., *P. falcifolia* C.H.Wright, *P. filiformis* L. subsp. *filiformis*, *P. filiformis* L. subsp. nov., *P. galpinii* C.H.Wright, *P. glomerata* Thunb. subsp. *glomerata*, *P. glomerata* Thunb. subsp. nov., *P. montana* Thoday, *P. obtusifolia* Thoday, *P. paleacea* Wikstr., *P. paludosa* Thoday, *P. pendula* Eckl. & Zeyh., *P. rigida* Wikstr., *P. rubra* C.H.Wright, *P. vulgaris*, *P. sp. nov. 1*, *P. sp. nov. 2*, *P. sp. nov. 3* and *P. sp. nov. 4*.

For almost three centuries evidence from floral morphology has been basic to plant taxonomy and applied at all hierarchical levels. Our research on the flowers in *Passerina* has produced new morphological and anatomical evidence, especially as Heinig's classical study of floral morphology in Thymelaeaceae (1951) did not include *Passerina*. The present study has succeeded in resolving the floral morphology in *Passerina*, as many mistakes have been perpetuated by previous authors. We conclude that the flower in *Passerina* is a phylogenetically advanced structure and consider the genus advanced

within the Thymelaeoideae. Possible taxonomic relationships of the Thymelaeaceae with the Malvales are strongly supported by the presentation of floral morphological, anatomical, embryological and palynological information to which this study has also contributed. Finally, all the above-mentioned evidence serves to form a firm taxonomic basis for future comparative studies, especially in the expanding molecular field.

# ACKNOWLEDGEMENTS

The authors wish to thank Dr E. Steyn for assistance with the LM, Ms G. Condy for the line drawings and Ms A. Romanowski for the developing and printing of the photographs.

# REFERENCES

- ALVERSON, W.S., KAROL, K.G., BAUM, D.A., CHASE, M.W., SWENSEN, S.M., MCCOURT, R. & SYTSMA, K.J. 1998. Circumscription of the Malvales and relationships to other Rosidae: evidence from *rbcl* sequence data. *American Journal of Botany* 85: 876–887.
- ANGIOSPERM PHYLOGENY GROUP (APG). 1998. An ordinal classification for the families of flowering plants. *Annals of the Missouri Botanical Garden* 85: 531–553.
- ARCHANGELSKY, D.B. 1971. Palynotaxonomy of the Thymelaeaceae s.l. In L.A. Kuprianova & M.S. Jakovlev, *Pollen morphology*: 104–234. (In Russian.) Academy of Science, USSR, Komarov Botanical Institute, Leningrad.
- BENTHAM, G. & HOOKER, J.D. 1880. *Genera plantarum* Vol. 3. Cramer, Weinheim.
- BEYERS, J.B.P. 1992. *The generic delimitation of Lachnaea and Cryptadenia (Thymelaeaceae)*. M.Sc. thesis, University of Stellenbosch, Stellenbosch.
- BEYERS, J.B.P. 1997. New combinations in *Lachnaea* (Thymelaeaceae). *Bothalia* 27: 45.
- BEYERS, J.B.P. & VAN DER WALT, J.J.A. 1995. The generic delimitation of *Lachnaea* and *Cryptadenia* (Thymelaeaceae). *Bothalia* 25: 65–85.
- BOND, P. & GOLDBLATT, P. 1984. Plants of the Cape flora: a descriptive catalogue. *Journal of South African Botany* 13: 1–455.
- BREDENKAMP, C.L. & VAN WYK, A.E. 1996. Palynology of the genus *Passerina* (Thymelaeaceae): relationships, form and function. *Grana* 35: 335–346.
- BREDENKAMP, C.L. & VAN WYK, A.E. 2001. Leaf anatomy of the genus *Passerina* (Thymelaeaceae): taxonomic and ecological significance. *Bothalia* 31: 53–70.
- BUNNIGER, L. 1972. Untersuchungen über die morphologische Natur des Hypanthiums bei Myrtales- und Thymelaeales-Familien. *Beiträge zur Biologie der Pflanzen* 48: 79–156.
- CONTI, E., LITT, A. & SYTSMA, K.J. 1996. Circumscription of Myrtales and their relationship to other rosids: evidence from *rbcl* sequence data. *American Journal of Botany* 83: 221–233.
- CORNER, E.J.H. 1976. *The seeds of dicotyledons*. Vols 1, 2. Cambridge University Press, Cambridge.
- CRONQUIST, A. 1968. *The evolution and classification of flowering plants*. Houghton Mifflin, Boston.
- CRONQUIST, A. 1981. *An integrated system of classification of flowering plants*. Columbia University Press, New York.
- CRONQUIST, A. 1988. *The evolution and classification of flowering plants*. The New York Botanical Garden, Bronx, New York.
- DAHLGREN, R.M.T. 1975a. A system of classification of the angiosperms to be used to demonstrate the distribution of characters. *Botaniska Notiser* 128: 119–147.
- DAHLGREN, R.M.T. 1975b. The distribution of characters within an angiosperm system. I. Some embryological characters. *Botaniska Notiser* 128: 181–197.
- DAHLGREN, R.M.T. 1980. A revised system of classification of the angiosperms. *Botanical Journal of the Linnean Society* 80: 91–124.
- DAHLGREN, R.M.T. & THORNE, R.F. 1984. The order Myrtales: circumscription variation, and relationships. *Annals of the Missouri Botanical Garden* 71: 633–699.
- DAHLGREN, R.M.T. & VAN WYK, A.E. 1988. Structure and relationships of families endemic to or centred in southern Africa. *Monographs in Systematic Botany* 25: 1–94.
- DAVIS, G.L. 1966. *Systematic embryology of the angiosperms*. Wiley, New York.
- DOMKE, W. 1934. *Untersuchungen über die systematische und geographische Gliederung der Thymelaeaceen*. E. Schweizerbart'sche Verlagsbuchhandlung (Erwin Nägele) G.M.B.H., Stuttgart.
- ECKARDT, T. 1937. Untersuchungen über Morphologie, Entwicklungsgeschichte und systematische Bedeutung des pseudomonomeren Gynoeceums. *Nova Acta Leopoldina* 5: 43–48.
- ENDLICHER, S. 1837. *Genera plantarum*. Beck, Vienna.
- ENDLICHER, S. 1847. *Genera plantarum*, Suppl. 4, edn 2. Beck, Vienna.
- FAHN, A. 1967. *Plant anatomy*. Pergamon Press, London.
- FEDER, N. & O'BRIEN, T.P. 1968. Plant microtechnique: some principles and new methods. *American Journal of Botany* 55: 123–142.
- GILG, E. 1891. Thymelaeaceae. *Die natürlichen Pflanzenfamilien* 3: 216–245.
- GILG, E. 1894. Studien über die Verwandtschaftsverhältnisse der Thymelaeales und über die 'anatomische Methode'. *Botanische Jahrbücher* 18: 489–574.
- HEINIG, K.H. 1951. Studies in the floral morphology of the Thymelaeaceae. *American Journal of Botany* 38: 113–132.
- HUTCHINSON, J. 1973. *The families of flowering plants*, edn 3. Clarendon Press, Oxford.
- KARNOVSKY, M.J. 1965. A formaldehyde-glutaraldehyde fixative of high osmolality for use in electron microscopy. *Journal of Cell Biology* 27: 137a.
- LEANDRI, J. 1930. Recherches anatomiques sur les Thymélacées. *Annales des Sciences Naturelles Botanique* 12: 125–237.
- LINNAEUS, C. 1781. *Supplementum plantarum*. Impensis Orphanotropei, Brunsvigae.
- LINNAEUS, C. 1784. *Systema vegetabilium*. Dieterich, Göttingae.
- MAGALLÓN, S., CRANE, P.R. & HERENDEEN, P.S. 1999. Phylogenetic pattern, diversity, and diversification of eudicots. *Annals of the Missouri Botanical Garden* 86: 297–372.
- MEISNER, C.F. 1857. Ordo CLXVII. Thymelaeaceae. *Prodromus systematis naturalis* 14: 493–605. Masson, Paris.
- MELCHIOR, H. 1964. A. Engler's Syllabus der Pflanzenfamilien, edn 2. Gebrüder Borntraeger, Berlin.
- NOEL, A.R.A. 1983. The endothecium—a neglected criterion in taxonomy and phylogeny? *Bothalia* 14: 833–838.
- PETERSON, B. 1978. Thymelaeaceae. *Flora of tropical East Africa*: 1–37. Whitefriars Press, London.
- RAO, V.S. & DAHLGREN, R. 1969. The floral anatomy and relationships of Oliniaceae. *Botaniska Notiser* 122: 160–171.
- RICHARDS, A.J. 1986. *Plant breeding systems*. Allen & Unwin, London.
- SPJUT, R.W. 1994. A systematic treatment of fruit types. *Memoirs of the New York Botanical Garden* 70: 1–182.
- STEBBINS, G.L. 1974. *Flowering plants. Evolution above the species level*. Edward Arnold, London.
- TAKHTAJAN, A. 1969. *Flowering plants: origin and dispersal*. Oliver & Boyd, Edinburgh.
- TAKHTAJAN, A. 1997. *Diversity and classification of flowering plants*. Columbia University Press, New York.
- THODAY, D. 1924. XVIII. A revision of *Passerina*. *Kew Bulletin* 4: 146–168.
- THORNE, R.F. 1992a. Classification and geography of the flowering plants. *The Botanical Review* 58: 225–348.
- THORNE, R.F. 1992b. An updated phylogenetic classification of the flowering plants. *Aliso* 13: 365–389.
- WEBERLING, F. 1983. Fundamental features of modern inflorescence morphology. *Bothalia* 14: 917–922.
- WEBERLING, F. 1989. *Morphology of flowers and inflorescences*. Cambridge University Press, Cambridge.
- WEBERLING, F. & HERKOMMER, U. 1989. Untersuchungen zur Infloreszenzmorphologie der Thymelaeaceen. *Tropische und Subtropische Pflanzenwelt* 68: 7–124.
- WIKSTROM, J.E. 1818. Granskning af de till Thymelaeaceae Vaxtordning hörande Slågten och Arter. *Kungliga Svenska vetenskapsakademiens handlingar*: 265–355.



## Miscellaneous notes

### ALOACEAE

#### ARE OVULES AND SEEDS IN *LOMATOPHYLLUM* WILLD. (*ALOE* SECT. *LOMATOPHYLLUM* SENSU AUCT.) ANATROPOUS AND EXARILLATE?

##### INTRODUCTION

The seeds of all aloes are enveloped by an extra tissue that forms an additional covering to the seed coat (Dahlgren *et al.* 1985). Known as an aril and sometimes referred to as a third integument (Joshi 1937; Danilova *et al.* 1995), this tissue arises early in the development of the aloe ovule as a cup-shaped outgrowth of the placenta (Schnarf & Wunderlich 1939) or base of the funicle (McNaughton & Robertson 1974). The presence of the broad, impeding structure developing so early and close to the base of the ovule has a profound influence on the ultimate shape of the ovule: instead of turning through 180° to reach a completely upside-down (anatropous) position, the ovule primordium only completes a 90° turn and becomes hemitropous (Steyn & Smith 1998: fig. 2A). Morphologically, mature ovules of aloes therefore show two very distinctive characters, namely hemitropy and broad aril primordia (Steyn & Smith 1998).

In fertilized ovules the aril immediately starts growing around the developing seed to form a succulent membrane which completely covers the hemitropous seed body. The succulent tissue of the aril may have adaptive value by acting as a handy, nearby reservoir for supplying water to the vital, inner ovular tissues in times of water stress. Having grown around the developing seed, the aril possibly keeps the tender, immature seed in a moist atmosphere. As seed development progresses, the aril tissue extends laterally to fill the spaces among the seeds in the locules of the capsule (E.M.A. Steyn pers. obs.). In this way, the wings of aloe seeds are formed. The shape and size of the wings may be moulded by the available space in the developing locule (Werker 1997). In some aloes, for instance *Aloe asperifolia* A.Berger, *A. claviflora* Burch., *A. falcata* Baker and *A. variegata* L. the wings can be large, frilly structures, while in others the wings are less elaborate or sometimes absent (Kamstra 1968; Reynolds 1982). At seed maturity the succulent aril tissue dries out and becomes papery when the cartilaginous capsule splits open. The winged seeds are then released to be dispersed by wind.

It has been reasoned that character states may be lost during evolution of a taxon if they become functionally superfluous, e.g. an aril will easily become rudimentary if the fruit becomes indehiscent (Dahlgren 1991). The question therefore arises whether this has happened in about 20 species of aloe look-alikes occurring on Madagascar and the neighbouring islands of Aldabra, Réunion, Mauritius and Rodrigues. Unlike all other members of the Aloaceae, these species do not bear capsular fruit, but produce fleshy-fruited, colourful berries containing wingless black seed (Rowley 1996). Although some of these 'berried aloes' (Rowley 1996) occur in dry mountainous situations or on dry, hilly banks (Baker

1877), they generally favour a warm, humid forest climate and rely on animals (birds?) for the dispersal of their seed (Rauh 1993, 1998). If the wingless seed in the berries of *Lomatophyllum* have lost their arils, one would then expect reports of anatropy in the berried aloes—suppression of aril development would allow curvature of the ovule to the anatropous position.

During a preliminary evaluation of literature dealing with ovule morphology in Asphodelaceae (Steyn & Smith 1997) we noticed that Schill (1973) described the ovules of *Lomatophyllum* Willd. as anatropous, although the presence (or absence) of an aril was not mentioned in this 1973 report. However, subsequent research (Steyn & Smith 1998) on ovule structure in the genera of the Aloaceae did not include *Lomatophyllum* ovules, since suitable material was not available at the time. In addition to rectifying this omission, the present paper also includes a report on seed development and seed coat structure of *L. purpureum* (Lam.) T.Durand & Schinz.

##### MATERIAL AND METHODS

Open flowers and berries were collected in the nurseries of the National Botanical Institute, Pretoria from cultivated plants of *Lomatophyllum purpureum* (Accession No. GPTA 31155). The plants were propagated from seed, originally collected by Dr Wendy Strahm on Mauritius in 1988. For the present study, ovaries, developing berries and ripe seed were dissected from the flowers or fruit and fixed for 24 h in a 0.1 M cacodylate buffered solution (pH 7.4) containing 4% formaldehyde and 2.5% glutaraldehyde. By following the methods of Feder & O'Brien (1968), ovules and seeds were dehydrated in an alcohol series and impregnated with glycol methacrylate (GMA). The ovules and seed were subsequently imbedded in GMA and sectioned in a sagittal plane at a thickness of 2–3 µm on a Jung RM 2045 microtome. Median sagittal sections were stained with the periodic acid/Schiff reaction and counterstained with toluidine blue O (pH 4.4) by using the protocols of O'Brien & McCully (1981).

##### RESULTS

##### *Orientation and structure of ovules*

The sessile, trilocular ovary of *Lomatophyllum purpureum* contains many ovules. Each locule holds several ovules alternately arranged in two longitudinal rows and obliquely placed on axile placentae. The ovules are pleurotropic, i.e. the micropyles are turned outwards, facing the nearest septum (Figure 1). In each ovule the micropylar-chalazal (i.e. longitudinal) axis of the ovule is perpendicular to the longitudinal axis of the short funicle (Figure



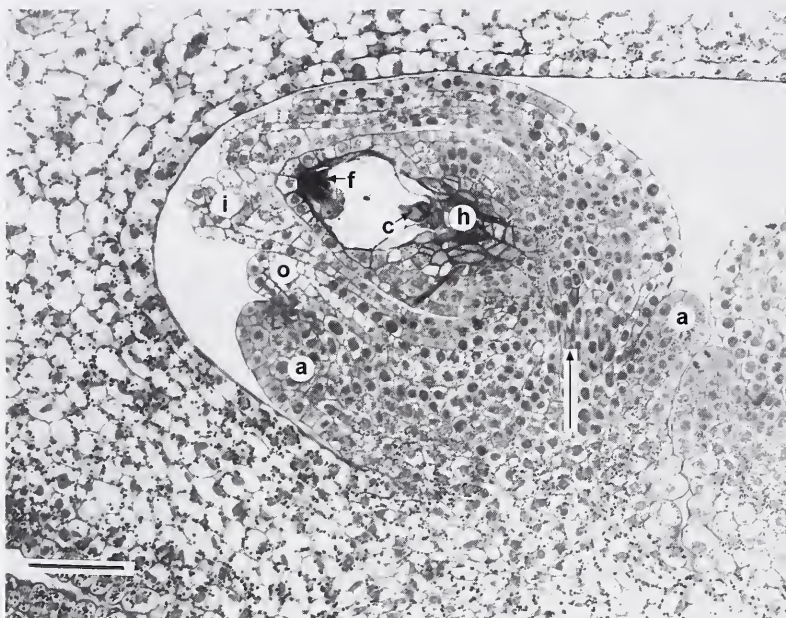


FIGURE 1.—Mature ovule of *Lomatophyllum purpureum* in sagittal view, seen in an oblique section of ovary: a, aril; c, central cell nucleus; f, filiform apparatus of synergid; h, hypostase in chalazal nucellus; i, inner integument forming endostome; o, outer integument. Direction of longitudinal axis of short funicle indicated by arrow. Scale bar: 100  $\mu$ m.

1). Thus, during early development and curvature towards the anatropous position, the ovules of *L. purpureum* have only turned through 90° to become hemitropous.

At the base of the ovule, the aril forms a conspicuous, broad and many-layered podium for the virtually sessile, bitegmic ovule (Figure 1). The outer integument is three-layered and slightly shorter than the two-layered inner integument, so that the latter alone forms the micropyle canal. Around the endostome the inner integument comprises more than two layers and here the cells have increased in size. The embryo sac is relatively large, having penetrated into the greater part of the micropylar nucellus, and only the nucellus epidermis has remained. The micropylar part of the embryo sac contains an egg cell and two prominent synergids with conspicuous, striated and strongly PAS-positive filiform apparatus. A

large central cell nucleus, situated directly above three ephemeral antipodes, occupies the chalazal part of the embryo sac. The base of the embryo sac is sunken into the chalazal nucellar tissue. The nucellus cells surrounding the base have developed into a prominent hypostase consisting of thick-walled, dark-staining cells which possibly prevented further penetration of the embryo sac into the chalazal nucellus.

#### Development and structure of aril and seed coat

After fertilization the aril rapidly expands to enfold the developing seed (Figure 2A). At this stage, the aril tissue comprises several layers of thin-walled cells with living protoplasts (Figure 2B). Except for the notably large cells of the outer epidermis and scattered idioblasts, the cells of the aril are small and densely packed (Figure

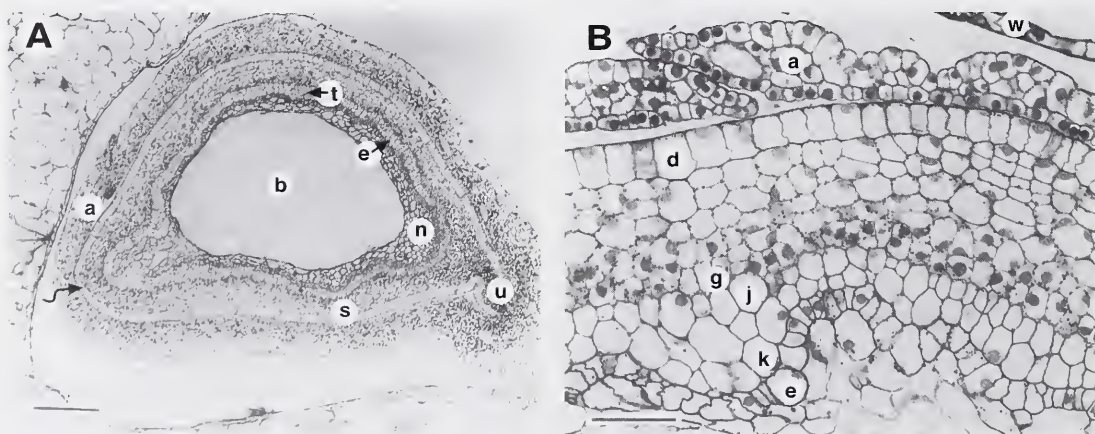


FIGURE 2.—Seed development in *Lomatophyllum purpureum*. A, median sagittal section of young seed; B, structure of developing aril and seed coat in sagittal section: a, aril; b, enlarging embryo sac; d, outer epidermis of testa; e, epidermis of nucellus; g, inner epidermis of testa; j, outer epidermis of tegmen; k, inner epidermis of tegmen; n, chalazal nucellus; s, developing testa; t, developing tegmen; u, funicle; w, fruit wall. Position of micropyle indicated by curved arrow. Scale bars: A, 500  $\mu$ m; B, 100  $\mu$ m.

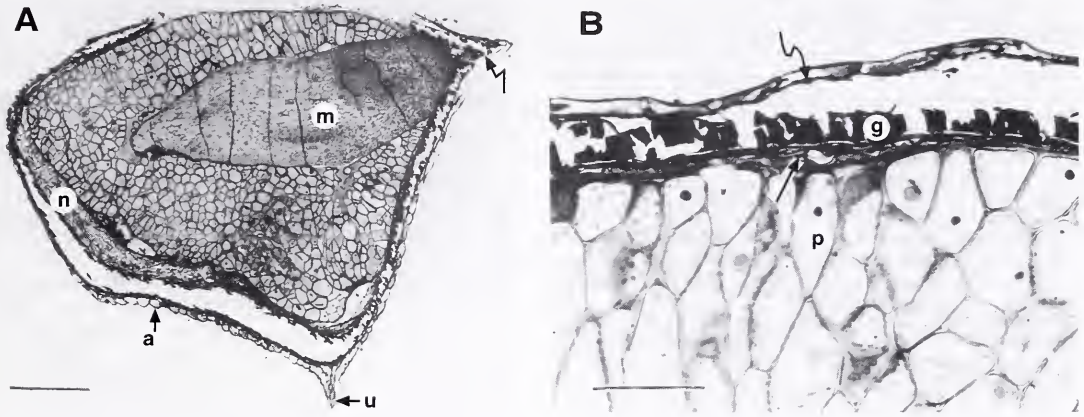


FIGURE 3.—Mature seed structure in *Lomatophyllum purpureum*. A, ripe seed in longitudinal section showing: a, aril; m, large straight embryo in endosperm; n, some remains of nucellus; u, funicle. Position of micropyle indicated by curved arrow. B, structure of aril and seed coat in ripe seed: curved arrow, outer epidermis of aril; straight arrow, flattened cell layers of testa and tegmen; g, outer epidermis of testa filled with phytomelan; p, endosperm. Scale bars: A, 500  $\mu$ m; B, 100  $\mu$ m.

2A, B). During enlargement of the embryo sac and the concurrent increase in circumference of the seed, the aril possibly keeps pace by marginal growth, i.e. cell divisions in the overlapping tips. Later, when the endosperm becomes filled with reserves and seed ripening occurs, the thin-walled aril tissue collapses. Only the outer epidermis remains as a thin layer of tangentially stretched cells covering the seed (Figure 3A, B).

During the enlargement of the growing seed the layers of both the tegmen (inner integument) and testa (outer integument) are discernible. The tegmen comprises two to three layers of thin-walled and closely packed cells, easily discernible from the adjacent cells of the nucellus epidermis and testa (Figure 2A, B). At this stage, the testa consists of six to eight cell layers. The small, inner epidermal cells have large nuclei and are still in an actively dividing stage. The outer epidermis cells are noticeably larger than the cells of the other layers and later become filled with dark-staining deposits of phytomelan. Eventually, when seed ripening occurs, the structure of the outer epidermis cells breaks down, but the black pigment remains as a melanin crust covering the collapsed cell layers of the testa and tegmen (Figure 3B).

The hemitropous nature of the ovule is retained during seed development, although some curvature towards the ventral side occurs in the distal part of the funicle (Figure 2A). The ripe seed contains some remains of the nucellar tissue (perisperm) in the chalazal region. The linear embryo is straight and occupies more than three-quarters of the length of the seed (Figure 3A).

#### DISCUSSION AND CONCLUSIONS

Our results on *L. purpureum* strongly suggest that Schill's (1973) conception of anatropy in the ovules of *Lomatophyllum* was erroneous, and that ovule curvature in *Lomatophyllum* is arrested in the hemitropous stage of the ovule primordium by the presence of a broad aril at the base of the funicle. A re-evaluation of Schill's data strengthens our view: his own micrograph (Schill 1973: 277, fig. 3),

depicting a transverse section of the ovary of *L. citreum* Guillaumin, clearly shows hemitropous ovules above the aril primordia in the locules. This micrograph was not intended to illustrate ovule curvature, but to show that the dorsal walls of the locules in the fruit of *Lomatophyllum* remain intact and do not open by median splits like those of *Aloe viquieri* H.Perrier (Schill 1973: fig. 4).

During seed formation the growing seed of *L. purpureum* is eventually enfolded by arillate tissue. Although elaborate wings do not develop from this tissue as is often the case in *Aloe*, the remains of the aril can still be identified in the ripe, hemitropous seed. Internal ovular structure in *L. purpureum* also conforms to that of *Aloe* and the other genera of the Aloaceae (*Astroloba*, *Chortolirion*, *Gasteria*, *Haworthia* and *Poellnitzia*) investigated by Steyn & Smith (1998). Among the characters shared, are a prominent hypostase, a conspicuous central cell lying directly above the ephemeral antipodes and synergids containing striated, well-developed filiform apparatus that are strongly PAS-positive.

The results obtained in this investigation lend support for the proposal of Rowley (1996) to subsume *Lomatophyllum* under *Aloe*, but this may be an oversimplification of a rather intricate taxonomy (Rauh 1998). The genus remains controversial as evidenced by Newton (1998) who expressed the view that the species in the genus do not necessarily form a natural infra-generic group within *Aloe*.

#### REFERENCES

- BAKER, J.G. 1877. *Flora of Mauritius and the Seychelles: a description of the flowering plants and ferns of those islands*: 374. Reeve, London.
- DAHLGREN, G. 1991. Steps toward a natural system of the dicotyledons: embryological characters. *Aliso*: 107–165.
- DAHLGREN, R.M.T., CLIFFORD, H.T. & YEO, P.F. 1985. *The families of the monocotyledons: structure, evolution and taxonomy*: 179–182. Springer Verlag, Berlin.
- DANILOVA, M.F., NEMIROVICH-DANCHENKO, E.N., KOMAR, G.A. & LODKINA, M.M. 1995. The seed structure of monocotyledons. In P.J. Rudall, P.J. Cribb, D.F. Cutler & C.J. Hum-



- phries, *Monocotyledons: systematics and evolution*: 461–472. Royal Botanic Gardens, Kew.
- FEDER, N. & O'BRIEN, T.P. 1968. Plant microtechnique: some principles and new methods. *American Journal of Botany* 55: 123–142.
- JOSHI, A.C. 1937. Megasporogenesis in *Aloe vera* Linn. *Journal of the Indian Botanical Society* 15: 297–300.
- KAMSTRA, M.W. 1968. Aloe seeds. *Aloe* 6,2: 8–10, 23–27.
- MCNAUGHTON, J.E. & ROBERTSON, B.L. 1974. Megasporogenesis and megagametogenesis in *Aloe africana* Mill. *Journal of South African Botany* 40: 75–79.
- NEWTON, L.E. 1998. A new species of *Aloe* (Aloaceae) on Pemba, with comments on section *Lomatophyllum*. *Cactus and Succulent Journal* 70: 27–31.
- O'BRIEN, T.P. & McCULLY, M.E. 1981. *The study of plant structure: principles and selected methods*: 4.19–4.22, 6.81–6.88. Termacarpi, Melbourne.
- RAUH, W. 1993. *Lomatophyllum belavenokense* Rauh & Gerold spec. nov., a new species from south-eastern Madagascar. *Excelsa* 16: 1–6.
- RAUH, W. 1998. Three new species of *Lomatophyllum* and one new *Aloe* from Madagascar. *Bradleya* 16: 92–100.
- REYNOLDS, G.W. 1982. *The aloes of South Africa*, edn 4. Balkema, Cape Town.
- ROWLEY, G.D. 1996. The berried aloes: *Aloe* section *Lomatophyllum*. *Excelsa* 17: 59–62.
- SCHILL, R. 1973. Studien zur systematische Stellung der Gattung *Lomatophyllum* Willd.—ein Vergleich mit *Aloe* Tourn. (Liliaceae). *Beiträge zur Biologie der Pflanzen* 49: 273–289.
- SCHNARF, K. & WUNDERLICH, R. 1939. Zur vergleichenden Embryologie der Liliaceae–Asphodeloideae. *Flora* 133: 297–327.
- STEYN, E.M.A. & SMITH, G.F. 1997. Ovule structure in *Trachyandra saltii* (Asphodelaceae). *South African Journal of Botany* 63: 223–226.
- STEYN, E.M.A. & SMITH, G.F. 1998. Ovule orientation, curvature and internal structure in the Aloaceae. *South African Journal of Botany* 64: 192–197.
- WERKER, E. 1997. Seed anatomy. *Handbuch der Pflanzenanatomie*, special issue 10,3: 283. Borntraeger, Berlin.

E.M.A. STEYN\* and G.F. SMITH\*

\* National Botanical Institute, Private Bag X101, 0001 Pretoria.  
MS. received: 2000-11-27.



## OBITUARY

### HEINRICH JOHANN WILHELM GIESS (1910–2000)

Willi Giess (Figure 1), as he was known to most, was born on 21 February 1910 in Frankfurt am Main, Germany. He was the elder of the two sons of Wilhelm and Lilly Giess. He completed his schooling at the 'Adlerflycht Realschule' in Frankfurt in 1925. The Giess family then emigrated to South West Africa in 1926 (Kolberg & Strohbach 2000; Gunn & Codd 1981).

Willi Giess started working as a volunteer on farms at the tender age of 16 until he enrolled for a diploma in agriculture at the Neudamm Agricultural College near Windhoek from 1928 to 1929 (Kolberg & Strohbach 2000). He was one of the first three students that were registered at Neudamm. During his subsequent career he often re-visited Neudamm as a lecturer to try and impart his knowledge of local rangelands, as well as a love for the local flora, to budding young farmers.

In 1931 Willi Giess contracted Malta fever and, as was quite common in those days, was sent to Germany to recuperate. True to his nature, he was not satisfied with

spending time resting, but enrolled at the Animal Breeding Institute (Herdbuch-Abteilung der Karakulschafzucht, Tierzuchtinstitut der Universität Halle). He completed his training as Technical Adviser for Karakul Breeding in 1933 and returned to South West Africa where he applied his newly gained knowledge as manager of a karakul farm. After four years, Willi Giess purchased his own farm, Dornfontein-Süd, between Dordabis and Leonardville in the east-central part of the country (Kolberg & Strohbach 2000).

Soon World War II followed and Willi Giess, together with a number of others who later were to become well-known botanists, was interned at Andalusia (now Jan Kempdorp, South Africa) for six years. The 'Andalusia Camp University' was promptly established and under the guidance of the late Prof. O.H. Volk, Giess studied plant taxonomy. A number of plants were collected from the area in the camp that was accessible to internees, identified and drawn (Figure 2). He contributed significantly to the booklet *Bestimmungsschlüssel für südwest-afrikanische Grasgattungen* by producing engravings on tomato-box wood for the illustration of the key (Glen & Perold 2000). He was allowed to return to his farm in December 1946 after having collected plants in the Cape with the University of Stellenbosch as his base.

In 1953, initiated by Prof. Dr H. Walter of the University of Hohenheim, Germany, the Director of Agriculture, Dr J.S. Watt, agreed to establish a botanical section within the directorate. Prof. Walter donated over 2000 herbarium specimens and Willi Giess agreed to temporarily work on the development of a herbarium. For four years he travelled weekly from his farm Bergland, about 50 km south of Windhoek, into town. In 1957 the SWA Administration took Giess into permanent employment as curator of what was then the SWA Herbarium (Giess 1978). He held this post until his retirement in 1975, but continued to work in the herbarium until 1980 under the new curator, the late Dr Mike Müller (Gunn & Codd 1981). From April 1985 to January 1986 he was again acting curator while his successor completed his Ph.D. degree.

Willi Giess made an important contribution to the collection of what is now the National Herbarium of Namibia (WIND). Of the  $\pm 73\,000$  specimens in the present-day collection, about 18 750 were collected by him, often together with others like O. Volk, D. van Vuuren, B. de Winter and H. Merxmüller. These specimens were always collected in triplicate, often more. Anyone who has ever collected for a herbarium will appreciate the amount of work involved in such a collection. Even today, the Giess specimens, with their carefully typed or hand-written data labels, are often the best, if not the only ones of a certain species, to be found in the collection of the National Herbarium.



FIGURE 1.—Heinrich Johann Wilhelm Giess (1910–2000).

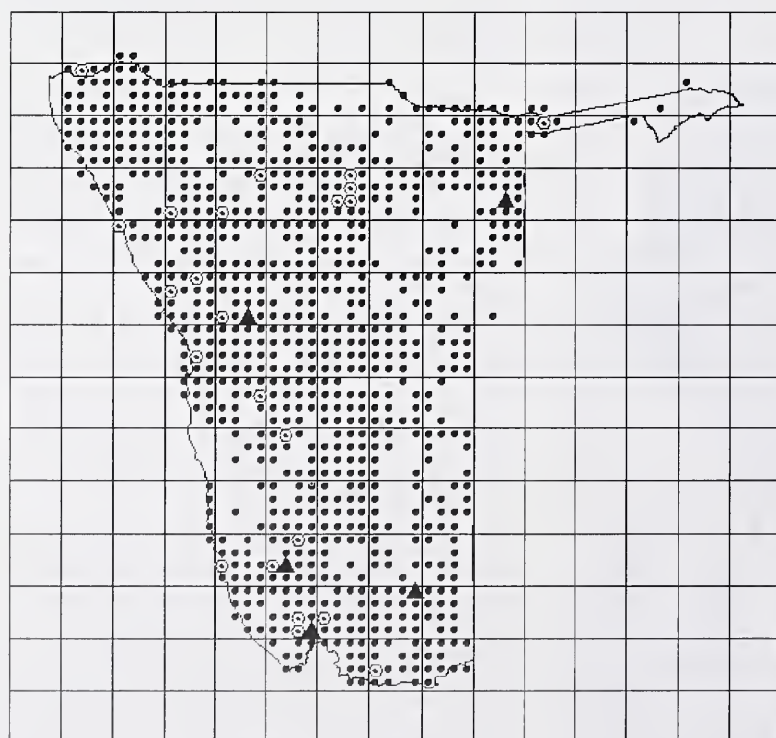


FIGURE 2.—*Ipomoea bolusiana* painted by W. Giess in 1942.

During his collecting trips, Giess covered almost the entire country (Figure 3). Important collections, which have to a large extent not been repeated in years following his expeditions, are those made in the Kaokoveld (later known as Bushmanland), Andara area on the Okavango River, Brandberg area, Lüderitz District (Aus, Zebrafontein, Namuskluft, Witpütz), Farm Ameib in the Erongo Mountains and the Kaokoveld. Plant collecting trips to the Kaokoveld in the late 1950s must have been quite a feat, considering that even to this day, with modern vehicles, equipment, maps, GPSs and improved roads, a trip to the Kaokoveld is considered somewhat of an adventure! The collected specimens of Merxmüller and Giess

were often the basis for taxon descriptions in the *Prodromus einer Flora von Südwestafrika*, the last volume of which was completed in 1971, and to date is still the only reference work for many Namibian plant groups.

Other collections that made a considerable difference to botanical knowledge in Namibia were his many index cards of indigenous plant names. When Willi Giess moved from Windhoek to Swakopmund, just two months before his death, these valuable boxes of cards were donated to the National Botanical Research Institute where they will be incorporated into a proposed publication of local common names for plants.



- Up to 100 specimens collected per grid
- Between 101 and 300 specimens collected per grid
- ▲ Between 301 and 600 specimens collected per grid

FIGURE 3.—Quarter-degree grid squares in Namibia where W. Giess collected herbarium specimens.

Willi Giess first published the journal *Dinteria* (named in honour of Prof. Kurt Dinter, Namibia's first official botanist) under the auspices of the South West Africa Scientific Society in November 1968. He remained editor until 1991 (vol. 21). The journal aimed at making contributions to the flora and vegetation of Namibia. In vol. 4 (1971), Giess first published his *Preliminary vegetation map of South West Africa*, which was re-printed twice—in 1978 and 1998, and is still the only approximation to a vegetation map of Namibia to this day (Kolberg & Strohbach 2000). Despite his very busy schedule, he managed to publish several papers (see end of this obituary; Giess 1989), ranging from popular to scientific articles, including the description of a number of new plant species: *Aloe argenticauda* Merxm. & Giess, *A. dewinteri* Giess, *A. namibensis* Giess, *Aristida dewinteri* Giess, *Sphaeranthus wattii* Giess ex Merxm., *Tridentea marientalesis* (Nel) L.C. Leach subsp. *albipilosa* (Giess) L.C. Leach and *Zygophyllum schreibermanum* Merxm. & Giess.

Whilst in retirement, Giess utilized his very comprehensive private literature collection to compile the *Bibliography of South West African Botany*, published by the SWA Scientific Society in 1989.

The pioneering work of Willi Giess did not go unnoticed in the international botanical world. He was honoured on several occasions: in July 1964, he became a Correspondent of the Naturhistorisches Museum in Vienna; in 1968, the Swedish Royal Academy of Sciences in Stockholm awarded him the Great Lineé Medal in Silver; on the 200th anniversary of the birth of Alexander von Humboldt, Willi Giess received a commemorative issue on the life of Von Humboldt from the consul of the Federal Republic of Germany to honour his achievements in the field of botany; the Bavarian Academy of Science honoured him with the Bene Merenti Medal for his contributions to the *Prodromus einer Flora von Südwestafrika*; the South African Association of Botanists awarded him a Certificate of Merit in 1979; in 1980, Giess received the Academy Medal in Gold from the South African Academy of Science and Arts; and in 1998, the Windhoek Municipality honoured Willi Giess by naming a street after him.

A number of plant species were named in honour of Giess, bearing testament to his collecting efforts and the assistance he gave to numerous scientists the world over: *Isoetes giessii* Launert, *Aizoon giessii* Friedrich, *Salsola giessii* Botsch., *Crassula ausensis* Hutch. subsp. *giessii* (Friedrich) Toelken, *Indigofera giessii* A. Schreb., *Zygophyllum giessii* (Merxm.) A. Schreb., *Euphorbia giessii* L.C. Leach, *Commiphora giessii* J.J.A. van der Walt, *Heliotropium giessii* Friedr.-Holzh., *Jamesbrittenia giessii* Hilliard, *Petalidium giessii* P.G. Mey., *Eriocephalus giessii* M.A.N. Müller, *Senecio giessii* Merxm., *Lachenalia giessii* W.F. Barker and *Stipagrostis giessii* Kers.

His keen interest and an eye for the unknown, meant that he often also collected insects associated with plants. In this way, a termite, *Okavangotermes giessii* (Coaton 1971), and a beetle, *Zophosis (Protodactylus) giessii* (Koch 1962), were also named after him since he collected the first specimens. The former is a monotypic genus and is known from only a single site east of

Rundu. The beetle is the most widespread of the *Protodactylus* subgenus and occurs along the outer margin of the Namib Desert from Gobabeb to Rosh Pinah.

I had the pleasure of working with Willi Giess for merely one year and was absolutely amazed by the wealth of his knowledge. For every species, locality or collector, he had some anecdote to tell or some memories to share. I remember going on a short field trip with him to collect material for Mike Müller, who was struggling through his Ph.D. in Stellenbosch. While passing his former farm Bergland, he showed me a fair-sized hill, which he had de-bushed manually in the early 1950s. To this day, the vegetation on this hill is visibly different from those nearby. Every little hill or farm we passed he would have something to say, like: 'Oh yes, *Aloe viridiflora* occurs in these koppies. I collected it there in 19.....' or 'When old so-and-so had this farm, the grazing conditions looked much better!' or 'We spent three days under this tree in 19.... when our car broke down and we had to wait for the Government Garage to send a mechanic.' I continued to be amazed by this extraordinary person when, about 20 years after retirement, he could still identify just about any plant you presented to him!

It was also a great inspiration to see Willi Giess and his wife Brigitte (formerly Bleissner) work together and support each other in all aspects of life. If one of them forgot where something was written or to be found, the other would remember. From 1963 to 1980 Brigitte Giess assisted her husband in the herbarium and accompanied him on his many collecting trips on a voluntary basis. Together with Volk they collected a large number of specimens in the early 1960s. Sadly his partner and soul-mate pre-deceased him in 1999.

Willi Giess died in Swakopmund on 28 September 2000. It is with sadness that we say farewell to our friend, colleague and mentor. Namibian botany would have been much the poorer without his invaluable pioneering work.

#### ACKNOWLEDGEMENTS

I gratefully acknowledge the information received from Dr E. von Koenen. Patricia Craven is thanked for producing the map, extracting information on Giess collections from the WIND database and making some valuable suggestions for inclusion in this text. The use of data from the National Botanical Institute, Pretoria, is gratefully acknowledged. My appreciation also to Eugene Marais for providing information on the insects mentioned in this article. Many thanks to Gillian Maggs-Kölling, who reviewed drafts of this paper.

#### REFERENCES

- GIESS, W. 1978. 25 Jahre Landesherbarium Südwestafrika. *Mitteilungen der SWA Wissenschaftlichen Gesellschaft* XIX/2: 3–5.
- GIESS, W. 1989. *Bibliography of South West African Botany*. SWA Scientific Society, Windhoek.
- GLEN, H.F. & PEROLD, S.M. 2000. Obituary: Otto Heinrich Volk (1903–2000). *Bothalia* 30: 215–224.
- GUNN, M. & CODD, L.E. 1981. *Botanical exploration of southern Africa*: 400. Balkema, Cape Town.
- KOLBERG, H. & STROHBACH, B. 2000. Obituary: Heinrich Johann Wilhelm Giess (1910–2000). *Dinteria* 26: 21–24.



## PUBLICATIONS BY W. GIESS

- EISEB, E., GIESS, W. & HAACKE, W.H.G. 1991. A preliminary list of Khoekhoe (Nama/Damara) plant names. *Dinteria* 21: 17–30.
- GAFF, D.F. & GIESS, W. 1985. Drought resistance in water plants in rock pools of southern Africa. *Dinteria* 18: 17–36.
- GIESS, W. 1962a. Some notes on the vegetation of the Namib Desert with a list of plants collected in the area visited by the Carp-Transvaal Museum Expedition during May 1959. *Cimbebasia* 2: 1–35.
- 1962b. Wunder unserer Flora—Wonderwêreld van ons plantegroei—Wonders of our flora. *Kleine Reih*e 5: 1–34. Afrika Verlag, Der Kreis, Windhoek.
- 1962c. Herbarium und Planzensammeln, aus der Praxis für die Praxis. *Wissenschaftliche Forschung in Südwestafrika* 1: 38–43. SWA Scientific Society, Windhoek.
- 1965. Die Vegetationsverhältnisse (des Schwarzen Nossobgebietes). In H.W. Stengel, Der Schwarze Nossob. *Wissenschaftliche Forschung in Südwestafrika* 4: 45–49. SWA Scientific Society, Windhoek. (translated into English and Afrikaans)
- 1966a. 'Veldkost' in Südwestafrika. *Journal of South West Africa Scientific Society* 20: 59–68.
- 1966b. *Hoodia parviflora* N.E.Br., eine für Südwestafrika neue *Hoodia*-Art. *Mitteilungen der Botanischen Staatssammlung, München* 6: 239–243.
- 1966c. Plankundige versamelingsritte in Suidwes-Afrika. *SWA Annual* 1966: 21–25.
- 1966d. The 'Veldkost' of South West Africa. *SWA Annual* 1966: 105–107.
- 1968a. Kurt Dinter. *Dinteria* 1: 4–7.
- 1968b. A short report on the vegetation of the Namib coastal area from Swakopmund to Cape Frio. *Dinteria* 1: 13–29.
- 1968c. Die Gattung *Rhigozum* Burch. und ihre Arten in Südwestafrika. *Dinteria* 1: 31–51.
- 1969a. Die Verbreitung von *Lindernia intrepida* (Dinter) Oberm. (*Chamaeigigas intrepida* Dinter) in Südwestafrika. *Dinteria* 2: 23–27.
- 1969b. Prodomus einer Flora von Südwestafrika. *Dinteria* 2: 29–36.
- 1969c. *Welwitschia mirabilis* Hook. fil. *Dinteria* 3: 1–55.
- 1970a. Eine neue *Aloe* aus der Namib (*Aloe namibensis* Giess). *Mitteilungen der Botanischen Staatssammlung, München* 8: 123–126.
- 1970b. Ein Beitrag zur Flora des Etosha Nationalparks. *Dinteria* 5: 19–55.
- 1970c. *Moringa ovalifolia*, die boom van die sprokieswoud in die Nasionale Etosha Wildtuin. *Dinteria* 5: 57, 58.
- 1970d. Die Verbreitung von *Moringa ovalifolia* Dinter & Berger in Südwestafrika. *Dinteria* 5: 59–64.
- 1970e. Pflanzenwunder in Vley, Pfannen und Wassertümpeln im trockenen Südwestafrika. *SWA Annual* 1970: 181–183.
- 1971a. Gramineae, a new species of *Aristida* from South West Africa. (*Aristida dewinteri* Giess). *Bothalia* 10: 365, 366.
- 1971b. A preliminary vegetation map of South West Africa. (Text in English, German & Afrikaans). *Dinteria* 4: 1–114.
- 1972a. Vegetation types. In W.G.H. Coaton & J.D. Sheasby, Preliminary report on a survey of the termites (*Isoptera*) of South West Africa. *Cimbebasia Memoir* 2: 15.
- 1972b. Der Botanische Garten auf der Farm Lichtenstein bei Windhoek im Jahre 1922. *Dinteria* 7: 13–15.
- 1973. A new species of *Aloe* from South West Africa. (*Aloe dewinteri* Giess). *Bothalia* 11: 120–122.
- 1974a. Zwei Fahrten zur *Jensenobotrya lossowiana* Herre. *Dinteria* 10: 3–12.
- 1974b. South West Africa: Flora. *Standard Encyclopedia of South Africa* 10: 149–150. Nasou, Cape Town.
- 1974c. Beobachtungen zur Südwester Flora. *Dinteria* 10: 35–44.
- 1974d. Eine neue Stapelie aus Südwestafrika. (*Stapelia albipilosa* Giess). *Mitteilungen der Botanischen Staatssammlung, München* 11: 349–352.
- 1976. A preliminary vegetation map of South West Africa. *Boissiera* 24: 651.
- 1978a. 25 Jahre Landesherbarium Südwestafrika. *Mitteilungen der SWA Wissenschaftlichen Gesellschaft XIX/2*: 3–5.
- 1978b. Die boom van die sprokieswoud in die Nasionale Etosha Wildtuin. *Staatsmuseum Windhoek* 9: 10–12.
- 1978c. Ein schöner botanischer Fund. (*Drosera indica*). *Mitteilungen der SWA Wissenschaftlichen Gesellschaft XIX/2*: 6.
- 1979. The genus *Crinum* in South West Africa. *The Indigenous Bulb Growers Association of South Africa* 28: 1–6.
- 1981a. Pflanzen der Namib. *SWA Annual* 1981: 34–41.
- 1981b. Eine botanische Namibfahrt. *SWA Annual* 1981: 81–86.
- 1981c. Die in der Zentralen Namib von Südwestafrika/Namibia festgestellten Pflanzenarten und ihre Biotope. *Dinteria* 15: 13–72.
- 1982a. Weitere Neunachweise zur Flora des Brandberges. *Dinteria* 16: 7–9.
- 1982b. Zur Verbreitung des Tabaks in Südwestafrika (*Nicotiana africana* Merxm.). *Dinteria* 16: 11–20.
- 1984a. Die Pflanzenwelt des Großen Gamsbergs. *Journal of South West Africa Scientific Society XXXVIII* : 29–47.
- 1984b. Short note on *Brachystelma blepharantthera* Huber. *Dinteria* 17: 81, 82.
- 1989a. Einiges zu unserer Flechtenflora. *Dinteria* 20: 30–32.
- 1989b. *Bibliography of South West African Botany*: 236. SWA Scientific Society, Windhoek.
- GIESS, W. & SNYMAN, J.W. 1986. The naming and utilisation of plant life by the Zu'hoasi Bushmen of the Kau-Kauveld. In R. Vossen & K. Keuthmann, *Contemporary studies on Khoisan I & II. In Honour of Oswin Köhler on the occasion of his 75th birthday*: 237–346. Buske, Hamburg.
- GIESS, W. & TINLEY, K.L. 1968. South West Africa (with vegetation map of SWA). Conservation of vegetation in Africa south of the Sahara. *Acta phytogeographica suecica* 54: 250–253.
- MERXMÜLLER, H. & GIESS, W. 1974. *Aloe pachygaster* Dinter und eine damit verwechselte neue Art. (*Aloe argenticauda*). *Mitteilungen der Botanischen Staatssammlung, München* 11: 437–444.
- ROBINSON, E.R. & GIESS, W. 1974. Report on the plants noted in the course of a trip from Lüderitz Bay to Spencer Bay, January 10–21, 1974. *Dinteria* 10: 13–17.

HERTA KOLBERG\*

\* National Plant Genetic Resources Centre, National Botanical Research Institute, Private Bag 13184, Windhoek, Namibia.

## Book Review

MEDICINAL, POISONOUS, AND EDIBLE PLANTS IN NAMIBIA by EBERHARD VON KOENEN, translation of German edn 2, *Klaus Hess Publishers*, Windhoek-Göttingen. 2001. Pp. 335, 128 full-page black-and-white drawings, 6 figures (maps and graphs). A4 size, hard cover. ISBN Namibia 99916-747-4-8, ISBN Germany 3-9804518-7-9. Price: ZAR 350.

'The rigid barriers that existed between conventional and alternative medicine are beginning to open up. The awareness is growing that the greatest benefit for the sick lies not in opposing but in combining the different methods of healing. Experience at my Windhoek surgery has shown the versatility and effectiveness of natural remedies in close collaboration with orthodox medicine. Many pharmacies which in the past stocked only pharmaceutical medicines, today keep large supplies of homeopathic and phytotherapeutic remedies'. Observations similar to these, made in the preface, are discussed in an article in the *New Scientist* of 26 May (Anon. 2001): 'Billions a year are spent worldwide on herbal medicines. In the US the use of complementary and alternative medicine has doubled in the past decade. In Britain almost half the adult population admits to using an alternative therapy'. In southern Africa more than 80 % of the population subscribe to traditional medical care. According to a recent estimate, some 20 million people in South Africa alone consume almost 20 000 tonnes of plant material per year during 90 million incidents of use (Mander 1998). Witness, therefore, the growing number of publications dealing with plants and their power to heal, to feed and to kill. A forthcoming publication by the National Botanical Institute (Arnold *et al.* in prep.) cites 16 major works dealing with African ethnomedicinal plants which have appeared during the last 10 to 12 years alone.

The predecessor of the present work first appeared in 1977 under the title *Heil- und Giftpflanzen in Südwestafrika*. It has since gone through several reprints and a second edition in German. The present book is a translation of this latest edition. Binding, paper and printing are still of a similar exceptionally high standard as in the first edition, and text and illustrations have been considerably expanded. The introductory chapter, *The Natural Environment*, presents an overview of the climate, geology, physiography and vegetation of Namibia, illustrated by maps, graphs and diagrams. Under the heading, *The Biotopes*, ten striking full-page pencil drawings of Namibian landscapes by the author are included, from barren wind-swept dune wastes and wide drainage lines supporting isolated specimens of *Welwitschia* in the Namib, to mopane savanna and the 'Fairy forest' along the Omaruru River.

Among the healers, and sometimes mischief-makers, as the author puts it, he distinguishes three main groups: the traditional healers, the soothsayers or clairvoyants and the black magicians. The soothsayer must have a disposition for spiritual perception, he tosses bones or sticks and draws conclusions from their position and thus finds the causes of diseases, disasters or inexplicable deaths. The black magician is an evil-doer; he sends disaster, lingering illness and death to others. The traditional healer uses many medicinal herbs, physical healing techniques and various utensils in order to invoke metaphysical forces to neutralise the symptoms of a disease. The essential role of the traditional healer is today recognised by Public Health Services in many parts of the world, including Namibia and southern Africa at large.

Dr von Koenen has acquired his knowledge of the healing, feeding and harmful potential of plants primarily in Namibia, from traditional healers and herb experts in all regions of the country. This is reflected in the many common names of plants in 13 of the languages spoken in Namibia. In the words of the author: 'In receiving and handing over this knowledge, I have also assumed the responsibility of pointing out incessantly that the healing plants are meant to serve the ill and not the greed for profit of unwelcome moneymakers'. Here he may have thought of species such as *Harpagophytum procumbens*, the Devil's claw or Grapple plant, here referred to as Wool spider: some 40 years ago a dreaded weed; today, due to its extreme popularity as a healing plant, especially in Central Europe, occasional to rare, except in more remote or protected areas. And there are numerous much rarer species which are seriously threatened by plant collectors. Von Koenen adds another caveat: 'It should not be expected that the whole range of medicinal herbs can be recommended for the pharmaceutical process. Interest should initially be focused on those plants which are used by different healers to treat more or less the same syndromes.'

The 600 species dealt with—two fungi, five ferns, one gymnosperm and 592 flowering plants—are numbered and arranged in alphabetical sequence with an indication of the family to which they belong. The 49 families of vascular plants represented are also shown on a separate alphabetical list ending with the two groups to which the two fungi belong. This is followed by a list of families in 'botanical' ( $\pm$  Englerian) order with all species of a given family arranged in alphabetical sequence. An alphabetical list of all species dealt with precedes a listing of the southern African distribution of all species in terms of countries or provinces. A diagram describing the degree square system and a map of Namibia explain the method according to which the distribution of species is indicated. Abbreviations used for the 13 ethnic groups or languages cited as source for the vernacular names are given, and the persons responsible for the naming and the descriptions of the species are mentioned. The bibliography comprises 45 literature sources.

The treatment of each species begins with the number assigned to it in the work, and, in the case of trees, with the National Tree Number. They are followed by the scientific name and family, and a list of the common names. For some of the more common plants, such as *Euclea divinorum*, the Wild ebony, or *Pterocarpus angolensis*, the Transvaal teak, vernacular names in ten different languages are listed, and for most other plants in at least three or more. The plant descriptions are brief and image-forming and the translators have attempted to follow the free, sometimes almost florid style of the author. The discussion of the importance of the plant is usually much longer than the descriptions, consisting, on average, of 200 words or more. The source of the information is indicated—no. 42 (Watt & Breyer-Brandwijk, *The medicinal and poisonous plants of southern and eastern Africa*, edn 2, 1962) is the most commonly cited reference. The species treatments end with an indication of the distribution in Namibia.

One hundred and seventeen species are illustrated on full-plate drawings by the author, 40 more than in the first German edition. The new drawings can easily be distinguished: they are not signed and dated by the author and shading on them is not brought about by stippling, as in the old drawings, but by stippling combined with grey toning. In contrast to the old drawings they therefore had to be screened before they could be printed. The grey tones often run over the lines, and the new drawings therefore tend to lack the clear outlines of the old ones. All in all, I prefer the ones from edition 1. In most cases the artist has caught enough diagnostic features to make the species recognisable. Soft leaves, however, often look leathery, and cylindrical organs may look rather flat. The drawing of *Diospyros lycioides* subsp. *lycioides* should rather have been omitted. The work ends with a list of vernacular names, a subject index excluding plant names, acknowledgements, subscriber list and a short curriculum vitae of the author.

Let me conclude with a brief quote from a typical conversation between the author and a traditional healer: 'I am doing this work not for my personal profit but in the interest of our country and our fellow countrymen. It must be done today, for the old, who still have the knowledge, will take it with them into the grave. And when you ask the young, you will mostly just get the reply: a pill is more convenient. But if some day the urgent question is asked about the medicinal plants which grow in our country—and the day will come—and there is nobody left who knows, this book, as the outcome of our work, will provide the answer'.

## REFERENCES

- ANON. 2001. Hype, hope and healing. *New Scientist* 2292: 28–30.
- ARNOLD, T., PRENTICE, C. A., HAWKER, L. C., SNYMAN, E. E., TOMALIN, M., CROUCH, N. R. & POTTS-BIRCHER, C. in prep. Medicinal and magical plants of southern Africa: an annotated checklist. *Srelitiza*.
- MANDER, M. 1998. *The marketing of medicinal plants in South Africa: a case study in KwaZulu-Natal*. FAO, Rome.
- WATT, J. M. & BREYER-BRANDWIJK, M. G. 1962. *The medicinal and poisonous plants of southern and eastern Africa*, edn 2. Livingstone, Edinburgh & London.





**National Botanical Institute South Africa:  
administration and research staff 31 March 2001,  
publications 1 April 2000–31 March 2001**

Compiler: B.A. Momberg

**CHIEF DIRECTORATE (ADIR)**

CAPE TOWN—PEARSON HOUSE

Huntley, Prof. B.J. M.Sc. Chief Executive Officer

Adams, Ms M.A. Typist/Receptionist

Laidler, Mrs S.A. B.Sc. (Agric.) (Hons) Personal Assistant

**MARKETING AND COMMUNICATION SUBDIRECTORATE (AMAR)**

CAPE TOWN

Moeng, S. M.A.(Languages). Deputy Director

Davis, G.W. Ph.D. Assistant Director. Programme Development/Fundraising

Cole-Rous, Ms J. B.A.(Hons.)(Linguistics), B.A.(French). Senior Communications Officer. Media

Mulder, Mrs G.P. Senior Pers. Assistant Cert.III. Secretary/Typist

Mafu, Ms N.N. Travel & Tourism Cert. Communications Officer. Tourism Development

**GRAPHIC SERVICES—CAPE TOWN (AMAR)**

Loedolff, Mrs J. B.Sc.(Ind.Tech.). Chief Industrial Technician. Photographer/Illustrator (part time)

**VISITORS CENTRE—CAPE TOWN (AMAR)**

Gibson-Dicks, Ms C. Senior Communications Officer. Centre Supervisor

Dyers, Mrs G. Nat.Sec.Cert.N6. Principal Typist I

Fredericks, Ms N.C.E. Senior Information Officer

Jacobs, A.P. Chief Information Officer

Jacobs, Ms B.C. Senior Administration Clerk I

**HUMAN RESOURCES DIRECTORATE (APER)**

CAPE TOWN

Tlali, P.L.N. B.Iuris Llb. Director. Human Resources

Letsoalo, M.R. B.A.(Hons.), Human Resources Management Cert. Assistant Director (Pretoria)

Cornelissen, Mrs A.M. Secretary to the Board

Finca, Ms N.F. Administration Aid II

Haupt, Mrs C.S. Administration Aid II. Guest house

Kriel, Mrs G.A. Dip.Sec. Senior Secretary IV

**PERSONNEL—CAPE TOWN**

Van Zyl, J.M. M.Econ.(Ind. Psych.). Assistant Director: Organizational Development & Training

Engelbrecht, B. N.Dip.(Hort.), N.Dip.(PRM), Dip.(Forestry). Assistant Director: Management and services

Staal, P.B. Industrial Relations Cert. Assistant Director: Labour relations

De Jonge, Ms K. Principal Typist II. Personnel Officer

Claassen, Ms G. Senior Telkom Operator I

Crowie, A.C. Senior Registry Clerk I

Dollie, Mrs N.J. Administration Aid II

Du Toit, Ms R. H.E.D. Senior Training Officer

Fredericks, C.H. Courier II

Mtyalela, D.M.S. Senior Training Officer

Nicholas, Mrs W.L. Senior Photocopy Machine Operator

Petersen, R.E. Principal Personnel Officer

Sass, Ms D. Administration Clerk II

Williams, Mrs L.R. Dip.Sec. Senior Personnel Officer II

**ADMINISTRATION AND HUMAN RESOURCES—PRETORIA (RPTA)**

Letsoalo, M.R. B.A.(Hons.), Human Resources Management Cert. Assistant Director

Götzel, Mrs A. Senior Telecom. Operator III  
 Khumalo, N.P. Principal General Foreman. Supervisor:  
 Office services  
 Makgobola, Mrs M.R. Administration Aid II. Cleaner  
 Malefo, Mrs R.P. Administration Aid II. Cleaner  
 Maphuta, Mrs M.S. Administration Aid II. Cleaner

Moswete, J.T. Principal Foreman. Maintenance  
 Nkosi, Mrs M.P. Administration Aid II. Cleaner  
 Phaahla, M.C. Administration Aid II. Cleaner  
 Sithole, A.M. Administration Aid I. Cleaner  
 Smuts, Mrs W.E. Administration Officer. Personnel

**FINANCE DIRECTORATE (AFIN)**

CAPE TOWN

Hughes, W.S.G. B.Com., C.A.(SA). Director  
 Maholwana, S. B.Com. Assistant Director. Financial Management  
 Neuwirth, Ms E.V. Assistant Director. Staff benefits  
 Rawoot, N.A. B.Acc.Sc. Assistant Director. Internal Audit

Africa, S. B.Tech. Internal Auditor  
 Bagus, Ms E.J. Senior Accountant: General ledger  
 Cassiem, Ms S. Senior Accounts Clerk III. Staff benefits  
 & salaries  
 Cooper, S.K. Accounts Clerk II  
 Geduldt, D.C. Senior Accounts Clerk I  
 Goodman, Mrs I.W. Chief Accounts Clerk. Creditors  
 Jacobs, F.H. Senior Accounts Clerk II. Salaries

Koyana, Ms Z. Senior Accounts Clerk I. Salaries  
 Mcontsi, Ms N. Accounts Clerk II. Finance  
 Mirkin, Ms Y.A. Senior Secretary II  
 Paulse, Mrs D.W.S. Senior Accounts Clerk III  
 September, Ms M. Senior Accounts Clerk I. Debtors  
 Yeomen, Mrs I.N. Senior Accounts Clerk III. Creditors  
 (contract worker)

**GARDENS DIRECTORATE—ADMIN STAFF (GDIR)**

PRETORIA

Willis, C.K. M.Sc. (Cons. Biol.)—Director: Gardens and Horticultural Services

CAPE TOWN

Le Roux, P.H. Deputy Director: Garden. Curator: Kirstenbosch NBG  
 Winter, J.H.S. N.Dip.(Hort.). Deputy Director: Horticultural Services

Woodward, Ms Y.J. Senior Administration Clerk III. Secretary

Behr, Ms C.M. Curator: Harold Porter NBG  
 Britz, R.M. Curator: Lowveld NBG  
 Turner, Ms S.L. Curator: Witwatersrand NBG  
 Heilgendorff, J.P. Curator: Pretoria NBG

Mogale, A.O. Curator: Free State NBG  
 Oliver, I.B. Curator: Karoo NBG  
 Tarr, B.B. Curator: Natal NBG

**PLANNING, MAINTENANCE & DEVELOPMENT—CAPE TOWN (BPMD)**

Linde, D.C. N.T.C.III(Technician and Inspector of Works). M.S.A.I.D. Cert. Estate Agency.  
 Control Inspector of Works

Arendse, D.S. Artisan's Assistant II. Building maintenance  
 Manasse, S.P. Dip.(Masonry). Foreman. Building maintenance  
 Peck, W.I. Artisan's Assistant II. Building maintenance

**HAROLD PORTER NBG—BETTY'S BAY (GHPG)**

Behr, Ms C.M. B.Sc.(Hons). Control Technician

Arendse, Ms M. Groundsman II. Gate  
 Bezuidenhout, Mrs H.M. Senior Administration Clerk III  
 Forrester, Ms J.A. N.T.C.III(Hort.). Chief Technician. Horticulture  
 Harper, C.C. Driver

Jacobs, L.H. Groundsman II. Plant sales  
 October, Ms R.P. Groundsman II. Plant records  
 Samuels, Ms D.C. Cleaner II  
 Van Wyk, A.B. Groundsman I. Index nursery

## KAROO NBG—WORCESTER (GKAR)

Oliver, I.B. N.Dip.(Hort.)(PRA). Control Technician

Ashworth, Mrs E.H. Senior Administration Clerk III  
Mpeke, Ms E.N. Cleaner II  
Sibozo, N.E. Driver II. Plant sales

Viljoen, D.M. N.Dip.(Hort.). Chief Technician. Collections  
Voigt, W.E. N.Dip.(Hort.) Technician

## KIRSTENBOSCH NBG—CAPE TOWN (GKBC)

Le Roux, P.H. N.Dip.(Hort.), N.Dip.(Parks & Rec.). Deputy Director: Garden. Curator.  
Head: Agricultural Support Services

Goldschmidt, S.M. B.A.(Soc.)(Hons.). Assistant Director. Personnel Management  
Morkel, A.T. N.Dip.(Nat. Cons.). Control Technician. Estate Manager  
Hitchcock, A.N. N.H.Dip.(Hort.). Control Technician. Supervisor: Nursery  
Jaques, R.F. Chief Technician. New plant introductions  
Notten, Ms A.L. B.Sc., N.Dip.(Hort.). Chief Technician. Supervisor: Seed room  
Trautman, C.E. Artisan. Supervisor: Workshop  
Adams, T.D. N.Dip.(Hort.). Technician. Greenhouse Supervisor

Arends, Ms S.J. Administration Clerk. Plant records  
Duncan, G.D. N.Dip.(Hort.). Chief Technician. Bulbs  
Engelbrecht, F. Storeman II  
Engelbrecht, Mrs L.D. Technician. Plant records  
Grace, T. Senior Storeman III  
Jamieson, Mrs H.G. N.Dip.(Parks & Rec.). Chief Technician. Restio/Asparagus (part time)  
Jodamus, Ms N.L. N.Dip.(Hort.). Senior Technician: Annuals  
Kamalie, Ms S. Typist II. Receptionist  
Lawrence, E. N.Dip.(Hort.). Senior Technician: Dell & Ericas  
Lewis, N.I. Engraver II. Senior Information Officer  
Manuel, I.P. Senior General Foreman. Seed room  
Mathys, Mrs S.S.B. Senior Accounts Clerk III. Gates

Picane, Ms S. Auxiliary Services Officer II. Tissue Culture  
Prins, F.B. Security Officer III  
Rudolph, A. Security Officer III  
Shaide, Ms A.C. Principal Communications Officer. Outreach Programme  
Smith, Mrs A. Senior Administration Clerk I  
Solomons, T.C. Senior Security Officer I  
Mbambenzi, N.G. N.Dip.(Hort.). Technician. Trees & shrubs  
Van der Walt, Mrs L.E. N.Dip.(Hort.). Chief Technician. Herbaceous collections (part time)  
Van Jaarsveld, E.J. M.Sc., N.Dip.(Hort.). Control Technician. Succulents  
Viljoen, Ms C.C. N.Dip.(Hort.). Senior Technician. Plant production  
Williams, G.C. Senior Accounts Clerk I

## LOWVELD NBG—NELSPRUIT (GLOW)

Britz, R.M. N.Dip.(Forestry). Control Technician

Froneman, W.C.F. N.Dip.(Nature Cons. & Man.), N.Dip.(Parks & Rec. Admin.), N.T.C.III(Hort.). Control Technician. Horticulture  
Hurter, P.J.H. B.Sc.(Hons). Control Technician. Research  
Maqungo, Ms V.L.B. Senior Accounts Clerk I. Kiosk

Mathebula, Ms N.R. Accounts Clerk II. Kiosk  
Ngwenya, P.S. Auxiliary Services Officer II. Kiosk  
Sibanyoni, Ms S.M. Administration Aid I. Cleaner  
Van der Walt, Mrs G.A.M. Senior Administration Clerk III

## NATAL NBG—PIETERMARITZBURG (GNAT)

Tarr, B.B. N.Dip.(Parks & Rec. Admin.), Advanced Dip.(Adult Educ.). Control Technician

Johnson, Ms I. B.Sc. Senior Technician  
Nonjinge, S.H.B. N.T.C.III(Hort.). Chief Technician  
Sibiya, Ms C.P.T. Administration Aid I. Cleaner

Van der Merwe, Mrs M.E.H. Senior Administration Clerk III

## FREE STATE NBG—BLOEMFONTEIN (GFSG)

Mogale, A.O. N.Dip.(Hort.). Control Technician

Eysele, Mrs J.P. Senior Administration Clerk III  
Harris, Ms S. N.Dip.(Hort.). Technician  
Lumley, M.J. Chief Scientific Officer. Nursery

Raditlhare, Mrs E.M. Administration Aid II  
Thaele, Mrs M.E. Administration Aid II



### PRETORIA NBG (GPTA)

Heilgendorff, J.P. H.N.Dip.(Hort.). Control Technician

- |   |  |
|---|--|
| Baloyi, K.J. Senior Auxiliary Services Officer II. Garden records   | Law, C. N.Dip.(Hort.). Senior Technician   |
| Baloyi, M.S. Dip.(IBM), Dip.(PTM), Dip.(Payroll Admin.). Senior Administration Clerk I. Personnel records   | Mariri, Ms M.A. Administration Aid II. Cleaner   |
| Creighton, Ms D.D. Administration Clerk III   | Matshika, S.P. Groundsman II. Cook   |
| Eyssell, Ms A. B.Sc.(Hons)(Agric.). Senior Technician. Production and sales nursery   | Modisha, M.D. Groundsman II. Cleaner   |
| Keyter, B.A. Senior Security Officer I  | Swartz, Ms P.P. M.Sc. Chief Horticulturist. Scientific and horticultural curation of living collections of succulents, orchids, medicinal and rare and endangered plants; garden planning and development; Madagascan plants; tour groups and visitors |
| Klapwijk, N.A. N.Dip.(Hort.), N.Dip.(Plant Prod.), N.Dip.(Diesel Fitting). Control Technician. Planning and development. Index nursery, New Plant Company | Venter, W.A. N.T.C.II. Senior General Foreman. Maintenance   |

### WITWATERSRAND NBG—ROODEPOORT (GWIT)

Turner, Ms S.L. B.Sc.(Hons), N.Dip.(Hort.). Control Technician

- |  |   |
|--|---|
| Aubrey, Mrs A.E. B.Tech.(Hort.). Senior Horticulturist. Plant records, interpretation, information | Mmola, Mrs B.E. Administration Aid II. Cleaner                  |
| Hankey, A.J. N.Dip.(Hort.). Specialist Horticulturist. Garden, estate, collections, nursery        | Mutshinyalo, T.T. N.Dip.(Hort.) Horticulturist. Nursery, garden |
| Head, Mrs S.E. Dip.(Typing). Administration Officer  | Ndzondo, Mrs P.G. Administration Aid II. Cleaner                |
| Manjati, Mrs N.L. Senior Administration Clerk I  | Tebeile, Ms Z.M. Senior Administration Clerk I. Receptionist    |

## RESEARCH DIRECTORATE (RDIR)

### PRETORIA

- Smith, Prof. G.F. Ph.D., F.L.S. Director: Research  
 Rutherford, M.C. Ph.D., Dip.(Datamet.). Deputy Director: Ecology and Conservation (Cape Town)  
 Wolfson, Mrs M.M. Ph.D. Deputy Director: Education and Research Support

- |   |   |
|---|---|
| Klopper, Ms R. M.Sc. Technician (contract worker) | worker)   |
| Marais, Mrs A.C. Senior Secretary IV              | Steyn, Dr E.M.A. D.Sc. Principal Scientist. Embryology, anatomy, taxonomy |
| Meyer, Mrs N.L. B.Sc.(Hons) Technician (contract  |   |

## PLANT SYSTEMATICS SUBDIRECTORATE

### PRETORIA

Smith, Prof. G.F. Ph.D., F.L.S. Systematics of succulents and rosulate, petaloid monocots

- Arnold, T.H. Head: Data Management (Pretoria)  
 Crouch, N.R. Head: Ethnobotany Unit (Durban)  
 Koekemoer, Miss M. Curator: National Herbarium (Pretoria)  
 Leistner, O.A. D.Sc. F.L.S. Scientist (contract worker)  
 Rourke, Dr J.P. Curator: Compton Herbarium (Cape Town)  
 Siebert, S.J. Regional Project Co-ordinator: SABONET (Pretoria)  
 Williams, Ms R. Curator: Natal Herbarium (Durban)

## COMPTON HERBARIUM—CAPE TOWN (RHEC)

Rourke, J.P. Ph.D., F.M.L.S., F.R.S.S.Af. Assistant Director. Systematics of southern African Proteaceae, Stilbaceae

- |   |  |
|---|--|
| Baatjes, Ms A. Data Capturer (SABONET contract worker)  | Curator: Collections. Taxonomy of the Gnidiaceae (Thymelaeaceae) |
| Beyers, Mrs J.B.P. Ph.D. Principal Scientist. Assistant | Chesselet, Ms P.C.M. M.Sc. Chief Scientific Officer              |

Conrad, Ms C. M.Sc. Scientist. Molecular systematics laboratory (SABONET contract worker)  
 Cupido, C.N. M.Sc.(Hons). Chief Scientific Officer  
 Cupido, Mrs C.S. Auxiliary Services Officer II. Technical Assistant  
 Engelbrecht, Ms M. (SABONET contract worker)  
 Foster, Mrs S.E. Senior Secretary IV  
 Kurzweil, H. Ph.D. Specialist Scientist. Systematics of southern African terrestrial orchids  
 Leith, Mrs J. Senior Administration Clerk III  
 Manning, J.C. Ph.D. Specialist Scientist. Systematics of Iridaceae and Orchidaceae; anatomy  
 Marinus, Ms E.D.A. Principal Auxiliary Services Offi-

cer. Herbarium Assistant  
 Oliver, E.G.H. Ph.D. Principal Scientist. Taxonomy of the Ericoideae (Ericaceae)  
 Oliver, Mrs I.M. (contract worker)  
 Parker, Ms F. B.Sc.(Hons). (SABONET contract worker)  
 Paterson-Jones, Mrs D.A. (née Snijman) Ph.D. Principal Scientist. Systematics of Amaryllidaceae; cladistics  
 Reeves, Ms G. Ph.D. Molecular systematics (contract worker)  
 Roux, J.P. N.T.C.III(Hort.), F.L.S., Ph.D. Principal Scientist. Systematics of Pteridophyta  
 Williams, Mrs V.J. Data Capturer (SABONET contract worker)

#### NATAL HERBARIUM—DURBAN (RHED)

Williams, Ms R. B.Sc.(Hons), H.D.E. Chief Scientific Officer

Govender, D. M.Sc. Student  
 Govender, Mrs N. B.Sc.(Hons) *Chironia* systematics (SABONET contract worker)  
 Hlongwane, Mrs N.C. Administration Aid II. Cleaner & messenger  
 Ngwenya, A.M. Senior Scientific Officer. Herbarium Assistant. Plant identification and information, Zulu

Plant Names Project  
 Mazibuko, J.V.G. Auxiliary Services Officer II. Herbarium Assistant  
 Noble, Mrs H-E. Senior Administration Clerk III  
 Ntuli, Mrs N. Data Capturer (SABONET contract worker)  
 Singh, Ms Y. M.Sc., H.E.D. Senior Scientist. Taxonomy of Araceae, *Hypoxis*

#### ETHNOBOTANY UNIT—DURBAN (RETH)

Crouch, N.R. Ph.D. Principal Scientist. Ethnobotany of southern African flora

#### NATIONAL HERBARIUM—PRETORIA (RHEN)

Koekemoer, Miss M. M.Sc. Assistant Director. Herbarium management. Taxonomy of Poaceae, Asteraceae: Gnaphalieae

Bredenkamp, Mrs C.L. M.Sc. Principal Scientist. Assistant Curator: Public relations. Taxonomy of *Vitex*, *Phyllica*, Rhamnaceae, Sterculiaceae and other related families.  
 Herman, P.P.J. M.Sc. Principal Scientist. Assistant Curator: Personnel. Taxonomy of Asteraceae, Flora of Transvaal

Anderson, H.M. Ph.D. Principal Scientist. Palaeobotany, palaeogeography  
 Anderson, J.M. Ph.D. Specialist Scientist. Palaeobotany, palaeogeography  
 Archer, R.H. Ph.D. Senior Scientist. Taxonomy of mainly Celastraceae, Euphorbiaceae  
 Archer, Mrs C. M.Sc. Senior Scientist. Taxonomy of Cyperaceae, Restionaceae, Orchidaceae  
 Burgoyne, Ms P.M. M.Sc. Senior Scientist. Mesembryanthemaceae  
 Cloete, Mrs M. Dip.(Typing). Senior Provisioning Clerk III. Specimen label typist  
 Fish, Mrs L. B.Sc. Principal Scientific Officer. Taxonomy of Poaceae. Plant collecting programme; supervising mounters  
 Gavhi, M.P. N.Dip.(Hort.) Kew Millennium Seedbank Project (contract worker)  
 Glen, H.F. Ph.D. Principal Scientist. Taxonomy of trees, herbarium for cultivated plants, and botanical collectors  
 Glen, Mrs R.P. M.Sc. Chief Scientific Officer. Taxonomy of ferns, water plants

Jordaan, Mrs M. M.Sc. Chief Scientific Officer. Taxonomy of Casuarinaceae—Connaraceae, *Maytenus*  
 Kgaditsi, W.T. Senior Auxiliary Services Officer. Mounter, general assistant in cultivated plants section  
 Makgakga, M.C. Senior Auxiliary Services Officer. Herbarium assistant, Wing B  
 Makgakga, K.S. Senior Auxiliary Services Officer. Mounter of vascular plants  
 Makwarela, A.M. B.Sc.(Hons). Senior Scientific Officer. Wing B  
 Masombuka, Ms A.S. Senior Auxiliary Services Officer. Herbarium assistant  
 Meyer, J.J. N.Dip.(Teaching). Senior Scientific Officer. Wing C  
 Mmakola, E.K. Data Capturer (SABONET contract worker)  
 Moeng, E.T. B.Sc. Scientific Officer. Wing A  
 Mothogoane, M.S. Senior Auxiliary Services Officer. Herbarium Assistant  
 Naicker, K. Sales & Marketing Management Certificate. Senior Administration Clerk II

- Netnou, Ms N.C. H.E.D., B.Sc.(Hons). Scientific Officer. Wing D
- Nkoana, L.S. B.Sc.(Hons). Senior Scientific Officer. SABONET project
- Nkoane, Ms G.K. Auxiliary Services Officer II. Herbarium Assistant. Parcelling, pressing, general assistance
- Nkonki, Mrs T. B.Sc. Scientific Officer. Wing B
- Perold, Mrs S.M. Ph.D. Taxonomy of Hepaticae (contract worker)
- Phahla, T.J. Senior Auxiliary Services Officer. Moulder of bryophytes and vascular plants
- Ready, Mrs J.A. N.Dip.(Hort.). Principal Auxiliary Services Officer. Herbarium assistant, Wing D
- Retief, Miss E. M.Sc. Principal Scientist. Pollen studies of Boraginaceae. Taxonomy of Boraginaceae, Verbenaceae, Lamiaceae, Asteraceae, Rubiaceae
- Sebothoma, P.N. Auxiliary Services Officer II. Plant identifications co-ordinator
- Smithies, Mrs S.J. M.Sc., Dip. Ed.(Moray House). Chief Scientific Officer. Taxonomy of Scrophulariaceae, Selaginaceae, Lobeliaceae
- Steyn, Ms C.C. Principal Auxiliary Services Officer. Wing B
- Swelankomo, Ms N. B.Sc. (SECOSUD contract worker)
- Van Rooy, J. Ph.D. Principal Scientist. Taxonomy and biogeography of mosses
- Van Wyk, E. M.Sc. Scientific Officer. Seedbank manager, Kew Millennium Seedbank Project (contract worker)
- Victor, Ms J.E. M.Sc., H.Dip.(Journ.). Chief Scientific Officer. Taxonomy of Rutaceae, Asclepiadaceae
- Welman, Miss W.G. M.Sc. Principal Scientist. Taxonomy of Convolvulaceae, Solanaceae, Cucurbitaceae, Campanulaceae, Asteraceae, Acanthaceae

#### DATA MANAGEMENT—PRETORIA (RPDC)

Arnold, T.H. M.Sc. Assistant Director. Computer application especially in taxonomy

- |  |  |
|--|--|
| Botha, Mrs A.G. Principal Auxiliary Services Officer. Secretary (part time)      | Smit, G.C. Network Essentials, NT Workstation 4, NT Server 4. Principal Network Controller |
| De Wet, Mrs B.C. B.Sc.(Computer Science), B.A., H.D.L.S. Principal Datametrician | Snyman, Mrs E.E. B.Sc. N.Dip.(Comp. Data Proc.) Senior Scientific Officer                  |
| Harris, Mrs B.J. Principal Auxiliary Services Officer. Encoding, quality control | Steyn, Ms H.M. Botanical Information Officer (contract worker)                             |
| Mbedzi, M.D. Senior Auxiliary Services Officer                                   | Van Rooyen, Mrs V.H. Principal typist I  |

#### SABONET PRETORIA

Siebert, S.J. M.Sc. Regional Project Co-ordinator

- |   |  |
|---|--|
| Golding, Ms J.S. B.Sc.(Hons). Southern African Red Data List Co-ordinator (contract worker) | Mössmer, Ms M. B.Sc. (Hons). Editing of publications, website management (contract worker) |
| Haasbroek, Ms C.M. Finances (contract worker)   | Noko, Ms N.R. Administrative Officer (contract worker)                                     |

#### EDUCATION AND RESEARCH SUPPORT—PRETORIA (EDIR)

Wolfson, Mrs M.M. Ph.D. Deputy Director. Physiology/Ecophysiology of Poaceae, carbon uptake metabolism, allocation in response to environmental and management stress

- Adams, Ms E.M. Principal Typist I. Secretary
- Liebenberg, Mrs E.J.L. Manager: Research Support Services, Publications, Registry and Finance
- Potgieter, Mrs E. Principal Librarian

#### EDUCATION (EDIR)

##### GOLD FIELDS CENTRE—CAPE TOWN (EECT)

Mkefe, T.X. SPTD. H.E.D. Assistant Director. Principal Communications Officer. Co-ordinator EE programme

- Cupido, Ms M. Senior Administration Clerk II. Centre co-ordinator
- Charlton, Ms V.J. Secretary
- Hitchcock, Mrs W.A. Principal Communications Officer. Adult education
- Mgodeli, W.M. Bus driver I
- Tyhokolo, Ms S.E. SPTD. Technician. Senior Communications Officer



## PRETORIA

Symonds, Ms A.M. N.Dip.(Nature Cons.), H.E.D. Assistant Director. Communication

De Bruyn, Ms A.J. B.Sc. (Zoo., Bot. & Mammalogy).  
Principal Communication Officer

tract worker)

Nkomo, Mrs A. Assistant Administration Officer (con-

Novellie, Mrs E. Education Officer (contract worker)  
Terblanche, Ms A.J. Principal Communications Officer

## WITWATERSRAND

Moore, Mrs J.M. Senior Administration Clerk I (contract worker) (part time)  
Van der Westhuizen, Mrs S. M.Sc.(Bot.). Principal Communications Officer

## INTERPRETATION

Joffe, Mrs H. B.Sc. Chief Garden Utilization Officer (part time) (Pretoria)  
Roff, J. Senior Administration Clerk I. Education Officer (Pietermaritzburg)

## RESEARCH SUPPORT SERVICES AND PUBLICATIONS—PRETORIA (RPUB)

Liebenberg, Mrs E.J.L. M.Sc. Chief Scientific Officer. Cytotaxonomy. Manager

Brink, Mrs S.S. Dip.(Typing). Chief Typesetter. Type-  
setting, layout, word processing

Condy, Ms G.S. M.A. Chief Industrial Technician.  
Botanical artist

Du Plessis, Mrs E. B.Sc.(Hons), S.E.D. Technical editor.  
Editing, translating, layout

Germishuizen, G. M.Sc. Assistant Director. Editor

Ledwaba, Mrs D.M. Senior Registry Clerk I

Mapheza, T.P. Senior Administration Clerk III. Book-  
shop

Momberg, Mrs B.A. B.Sc.(Entomology & Zoology). Tech-

nical editor. Editing, layout (part time)

Maree, Ms D.J. H.E.D. Computer Operator.

Nkosi, P.B. Administration Clerk II. Bookstore

Pretorius, Ms M.A. Senior Administration Clerk II

Romanowski, Mrs A.J. Dip.(Photography). Chief Indus-  
trial Technician (Photography). Scientific photog-  
rapher

Tloubatla, J.M. Driver II

Turck, Mrs S. B.A.(Information Design). Senior Indus-  
trial Technician. Graphic design

## MARY GUNN LIBRARY—PRETORIA (RLBP)

Potgieter, Mrs E. B.Libr. Principal Librarian

Fourie, Mrs A. B.A., H.D.Libr.Sci. Principal Librarian (part time)

## ECOLOGY AND CONSERVATION SUBDIRECTORATE (RREL)

## CAPE TOWN

Rutherford, M.C. Ph.D., Dip.(Datamet.). Deputy Director: Research

Morkel, Ms L. Senior Administration Clerk III. Personal Assistant to Deputy Director: Research

Parenzee, Ms H.A. Senior Administration Clerk III

Powrie, L.W. M.Sc. Chief Scientific Officer. Spatial modelling, databases

## CLIMATE CHANGE

Rutherford, M.C. Ph.D., Dip.(Datamet.). Chief Specialist Scientist. Modelling, global change

Arnolds, J.L. Principal Auxiliary Services Officer. Laboratory

Kgope, B.S. M.Sc. Scientist. Plant ecophysiology

Midgley, G.F. Ph.D. Specialist Scientist. Ecophysiology, modelling

Motete, Ms N. Scientist

Musil, C.F. Ph.D. Specialist Scientist. Ecophysiology, modelling

Snyders, S.G. Senior Auxiliary Services Officer II. Greenhouse, maintenance

## CONSERVATION BIOLOGY

Donaldson, J.S. Ph.D.(Zoology) Assistant Director. Supervisor: Conservation Farming. Cycad biology

Bösenberg, J.de Wet. B.Sc.(Hons) Chief Scientific Officer. Cycad biology, conservation farming

Cader, Ms L. Secretary. Protea Atlas Project (contract worker)

Ebrahim, I. Assistant. Protea Atlas Project (contract worker)

Jacobs, E.C. Senior Auxilliary Services Officer

Rebelo, AG. Ph.D.(Zoology) Principal Scientist. Protea Atlas Project

## CONSERVATION FARMING PROJECT

Nänni, Ms I. B.Sc., H.E.D. Chief Scientific Officer. Project Co-ordinator

Millar, Ms D.L. Research Co-ordinator (contract worker)

## DESERTIFICATION

Hoffman, M.T. Ph.D. Senior Specialist Scientist. Disturbance and historical ecology

Cloete, M.J. Fieldwork (contract worker)

Petersen, Ms A. B.Sc.(Hons). Senior Scientific Officer. Land use and vegetation mapping

## HORTICULTURAL RESEARCH

Brown, N.A.C. Ph.D. Specialist Scientist. Seed research

Botha, P.A. N.H.Dip.(Hort.). Chief Scientific Officer. Seed research

## INFORMATION TECHNOLOGY

O'Callaghan, M.G. Ph.D. Information Technology Manager. Information management and development

Evans, N. Network Controller. IT Support Officer (contract worker)

Pratt, Ms C. B.Sc. Network Controller (contract worker)

## SUPPORT SERVICES

Bardien-Overmeyer, Ms S. Auxiliary Services Officer. Manager (contract worker)

Bowler, Mrs M. Administration Aid II. Cleaner. Assistant: teas and functions

De Witt, D.M. Tradesman (B-Group). Assistant: maintenance

## HARRY MOLTENO LIBRARY (RRLC)

Reynolds, Ms P.Y. M.A.(Inf.Sc.), B.Proc. Dip. Datametrics. Principal Librarian, NBI Web Site Manager

Jagger, B.W. B.A. PG Dip.Lis. Senior Library Assistant II. Inter-library loans; circulation control

Ovens, Dr C.S.H. Ph.D.(Inf.Sc.) Dip.Datametrics. (contract librarian)

## PUBLICATIONS BY THE STAFF

1 April 2000–31 March 2001

ANDERSON, H.M. 2000. Review: Die infloreszenzen. Typologie und Stellung im aufbau des vegetationskörpers, by F. Weberling, 1998, *Bothalia* 30: 123.

ANDERSON, J.M. 2000. Review: Towards Gondwana Alive. Promoting biodiversity and stemming the Sixth Extinction, edited by J.M. Anderson, 1999. *Plantlife* 23: 35, 36.

ANDERSON, J.M. 2001. (ed.) *Towards Gondwana alive Vol. 1. Promoting biodiversity and stemming the Sixth Extinction*, edn

2. Gondwana Alive Society & National Botanical Institute, Pretoria.

ARCHER, C. 2000a. Burmanniaceae (Liliidae–Liliales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 587.

ARCHER, C. 2000b. Cannaceae (Zingiberidae–Zingiberales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 587.

- ARCHER, C. 2000c. Cyperaceae (Commelinidae–Cyperales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 594–605.
- ARCHER, C. 2000d. Flagellariaceae (Commelinidae–Restionales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 608.
- ARCHER, C. 2000e. Musaceae (Zingiberidae–Zingiberales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 643.
- ARCHER, C. 2000f. Restionaceae (Commelinidae–Restionales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 729–733.
- ARCHER, C. 2000g. Strelitziaceae (Zingiberidae–Zingiberales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 734, 735.
- ARCHER, C. 2000h. Zingiberaceae (Zingiberidae–Zingiberales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 739, 740.
- ARCHER, C. 2000i. Cyperaceae. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 81–92.
- ARCHER, R.H. 2000a. Achariaceae (Dilleniidae–Violales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 45, 46.
- ARCHER, R.H. 2000b. Anacardiaceae (Rosidae–Sapindales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 56–59.
- ARCHER, R.H. 2000c. Aquifoliaceae (Asteridae–Aquifoliales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 98, 99.
- ARCHER, R.H. 2000d. Balanitaceae (Rosidae–Sapindales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 171.
- ARCHER, R.H. 2000e. Balsaminaceae (Rosidae–Geraniales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 173.
- ARCHER, R.H. 2000f. Burseraceae (Rosidae–Sapindales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 196.
- ARCHER, R.H. 2000g. Buxaceae (Dilleniidae–Buxales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 196, 197.
- ARCHER, R.H. 2000h. Callitrichaceae (Asteridae–Lamiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 199.
- ARCHER, R.H. 2000i. Comaceae (Asteridae–Cornales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 234.
- ARCHER, R.H. 2000j. Dichapetalaceae (Rosidae–Malpighiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 242, 243.
- ARCHER, R.H. 2000k. Dioscoreaceae (Liliidae–Dioscoreales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 605, 606.
- ARCHER, R.H. 2000l. Dracaenaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 606.
- ARCHER, R.H. 2000m. Euphorbiaceae (Dilleniidae–Malpighiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 249–262.
- ARCHER, R.H. 2000n. Greyiaceae (Rosidae–Geraniales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 315, 316.
- ARCHER, R.H. 2000o. Haemodoraceae (Liliidae–Liliales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 609.
- ARCHER, R.H. 2000p. Icacinaeae (Rosidae–Icacinales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 321, 322.
- ARCHER, R.H. 2000q. Kirkiaceae (Rosidae–Sapindales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 322, 323.
- ARCHER, R.H. 2000r. Lanariaceae (Liliidae–Liliales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 640.
- ARCHER, R.H. 2000s. Malpighiaceae (Rosidae–Malpighiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 346.
- ARCHER, R.H. 2000t. Meliaceae (Rosidae–Sapindales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 353–356.
- ARCHER, R.H. 2000u. Melianthaceae (Rosidae–Sapindales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 356.
- ARCHER, R.H. 2000v. Ochnaceae (Dilleniidae–Theales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 426, 427.
- ARCHER, R.H. 2000w. Oliniaceae (Rosidae–Myrtales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 430.
- ARCHER, R.H. 2000x. Passifloraceae (Dilleniidae–Violales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 434–436.
- ARCHER, R.H. 2000y. Ptacroxylaceae (Rosidae–Sapindales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 461, 462.
- ARCHER, R.H. 2000z. Sapindaceae (Rosidae–Sapindales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 503–506.
- ARCHER, R.H. 2000za. Tecophilaeaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 735, 736.
- ARCHER, R.H. 2000zb. Velloziaceae (Liliidae–Liliales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 736, 737.
- ARCHER, R.H. 2000zc. Abstract: Taming *Euphorbia*: subgeneric classification in Africa. XVth AETFAT Congress, 28 August to 2 September 2000. *Scripta Botanica Belgica* 20: 9.
- ARCHER, R.H. & JORDAAN, M. 2000a. Celastraceae (Rosidae–Celastrales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 214–220.
- ARCHER, R.H. & JORDAAN, M. 2000b. Celastraceae. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 404–407.
- ARUMUGAM, N. 2000. News from South Africa. *Chironia* collecting trips. *SABONET News* 5: 69–72.
- ARUMUGAM, N. & NTULI, N.R. 2000. Life at Natal Herbarium. *SABONET News* 5: 15–17.
- BALKWILL, K. & WELMAN, W.G. 2000. Acanthaceae (Asteridae–Scrophulariales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 34–45.
- BARTHOLOTT, W. & SMITH, G.F. 2000. Obituary: Werner Rauh (1913–2000), one of the World's most prolific authors on succulent plants. *Bothalia* 30: 223, 224.
- BEYERS, J.B.P. 2000a. *Lachnaea* (Thymelaeaceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 680–683.
- BEYERS, J.B.P. 2000b. *Struthiola* (Thymelaeaceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 684, 685.
- BINGHAM, M., GOLDING, J., LUWIIKA, B., NGUVULU, C., SMITH, P. & SICHIMA, G. 2000. Red Data List: spotlight on Zambia. *SABONET News* 5: 93–95.
- BÖSENBERG, D. 2000. Save our species. The Albany cycad. *Africa—Environment & Wildlife* 8: 26, 27.
- BOTHA, C.J., SCHULTZ, R.A., VAN DER LUGT, J.J. & ARCHER, C. 2000. A krimpsiekte-like syndrome in small stock poisoned by *Ornithogalum toxicarium* Archer & Archer. *Journal of the South African Veterinary Association* 71: 6–9.
- BOTHA, D.J., WILLIS, C.K. & WINTER, J.H.S. 2000. *Southern African botanical gardens needs assessment*. SABONET Report No. 11.
- BOWIE, M.R., WAND, S.J.E. & ESLER, K.J. 2000. Seasonal gas exchange responses under three different temperature treatments in a leaf-succulent and a drought-deciduous shrub from the Succulent Karoo. *South African Journal of Botany* 66: 118–123.
- BREDENKAMP, C.L. 2000a. Araliaceae (Rosidae–Apiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 99, 100.
- BREDENKAMP, C.L. 2000b. Begoniaceae (Dilleniidae–Violales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 174.
- BREDENKAMP, C.L. 2000c. Bombacaceae (Dilleniidae–Malvales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 178.



- BREDENKAMP, C.L. 2000d. Canellaceae (Magnoliidae–Magnoliales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 202, 203.
- BREDENKAMP, C.L. 2000e. Clusiaceae (Guttiferae) (Dilleniidae–Guttiferales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 227.
- BREDENKAMP, C.L. 2000f. Combretaceae (Rosidae–Myrtales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 228, 229.
- BREDENKAMP, C.L. 2000g. Ebenaceae (Dilleniidae–Theales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 245.
- BREDENKAMP, C.L. 2000h. Elatinaceae (Dilleniidae–Guttiferales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 246.
- BREDENKAMP, C.L. 2000i. Erythroxylaceae (Rosidae–Linales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 248.
- BREDENKAMP, C.L. 2000j. Flacourtiaceae (Dilleniidae–Violales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 304–307.
- BREDENKAMP, C.L. 2000k. Frankeniaceae (Dilleniidae–Violales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 307, 308.
- BREDENKAMP, C.L. 2000l. Geissolomataceae (Rosidae–Celastrales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 309.
- BREDENKAMP, C.L. 2000m. Gunneraceae (Rosidae–Haloragidales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 317.
- BREDENKAMP, C.L. 2000n. Haloragaceae (Rosidae–Haloragidales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 317, 318.
- BREDENKAMP, C.L. 2000o. Lecythidaceae (Dilleniidae–Lecythidales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 336.
- BREDENKAMP, C.L. 2000p. Linaceae (Rosidae–Linales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 337, 338.
- BREDENKAMP, C.L. 2000q. Loasaceae (Dilleniidae–Violales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 338, 339.
- BREDENKAMP, C.L. 2000r. Lythraceae (Rosidae–Myrtales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 344–346.
- BREDENKAMP, C.L. 2000s. Melastomataceae (Rosidae–Myrtales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 352, 353.
- BREDENKAMP, C.L. 2000t. Menyanthaceae (Asteridae–Asterales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 359, 360.
- BREDENKAMP, C.L. 2000u. Onagraceae (Rosidae–Myrtales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 430, 431.
- BREDENKAMP, C.L. 2000v. *Passerina* (Thymelaeaceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 683, 684.
- BREDENKAMP, C.L. 2000w. Penaeaceae (Rosidae–Myrtales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 440–442.
- BREDENKAMP, C.L. 2000x. Plumbaginaceae (Caryophyllidae–Plumbaginales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 447, 448.
- BREDENKAMP, C.L. 2000y. Polygalaceae (Rosidae–Polygalales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 449–451.
- BREDENKAMP, C.L. 2000z. Rhamnaceae (Rosidae–Rhamnales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 465–467.
- BREDENKAMP, C.L. 2000za. Rhizophoraceae (Rosidae–Rhizophorales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 468, 469.
- BREDENKAMP, C.L. 2000zb. Sapotaceae (Dilleniidae–Sapotales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 506–508.
- BREDENKAMP, C.L. 2000zc. Sterculiaceae (Dilleniidae–Malvales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 539–541.
- BREDENKAMP, C.L. 2000zd. Tamaricaceae (Dilleniidae–Violales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 544.
- BREDENKAMP, C.L. 2000ze. Tiliaceae (Dilleniidae–Malvales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 547, 548.
- BREDENKAMP, C.L. 2000zf. Trapaceae (Rosidae–Myrtales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 548.
- BREDENKAMP, C.L. 2000zg. Turneraceae (Dilleniidae–Violales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 548–550.
- BREDENKAMP, C.L. 2000zh. Violaceae (Dilleniidae–Violales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 559, 560.
- BREDENKAMP, C.L. & ARCHER, R.H. 2000. Rhynchocalycaceae (Rosidae–Myrtales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 469.
- BREDENKAMP, C.L. & BEYERS, J.B.P. 2000. Thymelaeaceae (Dilleniidae–Euphorbiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 544–546.
- BREDENKAMP, C.L. & VAN WYK, A.E. 2000. The epidermis in *Passerina* (Thymelaeaceae): structure, function and taxonomic significance. *Bothalia* 30: 69–86.
- BREDENKAMP, C.L. & VICTOR, J.E. 2000. Gentianaceae (Asteridae–Gentianales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 310–312.
- BROWN, N.A.C. 2000. Consultation and photographs in Appendix 1: smoke and seed germination. In A. Stewart, *Let's propagate! A plant propagation manual for Australia*. Australian Broadcasting Corporation, Sydney.
- BROWN, N.A.C. & PROSCH, D. 2000. Storage and germination of *Clivia miniata* seeds. *Clivia Yearbook* 2: 59–62.
- BURGOYNE, P.M. 2000a. The enigmatic family Mesembryanthemaceae. Notes on identifying mesembs (vygies). *Plantlife* 23: 5–8.
- BURGOYNE, P.M. 2000b. Will the real *Ruschianthemum gigas* please stand up! *Aloe* 37: 8.
- BURGOYNE, P.M. 2000c. Abstract of poster: Systematics of Acrodon (Mesembryanthemaceae): what defines a genus? XVth AETFAT Congress, 28 August to 2 September 2000. *Scripta Botanica Belgica* 20: 10.
- BURGOYNE, P.M., BREDENKAMP, G.J. & VAN ROOYEN, N. 2000. Wetland vegetation in the North-eastern Sandy Highveld, Mpumalanga, South Africa. *Bothalia* 30: 187–200.
- BURGOYNE, P.M. & HENDERSON, L. 2000. Red-flowering tea-tree invasion. *Veld & Flora* 86: 159.
- BURGOYNE, P.M., KRYNAUW, S. & SMITH, G.F. 2000a. *Frithia*—up close and personal. *Aloe* 37: 38–42.
- BURGOYNE, P.M., KRYNAUW, S. & SMITH, G.F. 2000b. Abstract of poster: Population studies and new conservation status for species of the genus *Frithia* (Mesembryanthemaceae). XVth AETFAT Congress, 28 August to 2 September 2000. *Scripta Botanica Belgica* 20: 16.
- BURGOYNE, P.M., SMITH, G.F. & DU PLESSIS, F. 2000. Notes on the genus *Frithia* (Mesembryanthemaceae) and the description of a new species, *F. humilis*, in South Africa. *Bothalia* 30: 1–7.
- CHESSELET, P., SMITH, G.F., BURGOYNE, P.M., KLAK, C., HAMMER, S.A., HARTMANN, H.E.K., KURZWEIL, H., VAN JAARSVELD, E.J., VAN WYK, B-E. & LEISTNER, O.A. 2000. Mesembryanthemaceae (Caryophyllidae–Caryophyllales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 360–410.
- CHESSELET, P., SMITH, G.F. & VAN WYK, A.E. 2000a. Systematic and evolutionary significance of morphology in the Mesembryanthemaceae: interactive database and illustrated atlas for identification. *Aloe* 37: 46–51.
- CHESSELET, P., SMITH, G.F. & VAN WYK, A.E. 2000b. The habit and peculiar inflorescence of *Ottosonderia monticola* (Sond.) L.Bolus, Mesembryanthemaceae. *Aloe* 37: 88, 89.
- CONDY, G. 2000. Obituary: Rosemary Holcroft (1942–2000). *SABONET News* 5: 46, 47.
- CROUCH, N.R. 2000a. Preservation-through-propagation; the role of horticulture in delivering conservation products in southern Africa. *Southern African Ethnobotany* 1,3: 14–22.
- CROUCH, N.R. 2000b. Review: People's plants, by B-E. van Wyk & N. Gericke. 2000. *SABONET News* 5: 57, 58.
- CROUCH, N. 2001. Elliot Ndlovu: healer with a vision. *Palmnut Post* 4,1: 4–6.

- CROUCH, N.R., DONALDSON, J., SMITH, G.F., SYMMONDS, R., DALZIEL, C.G.M. & SCOTT-SHAW, C.R. 2000. *Ex situ* conservation of *Stangeria eriopus* (Stangeriaceae) at the Durban Botanic Gardens, South Africa. *Eucephalartos* 63: 16–24.
- CROUCH, N.R. & SMITH, G.F. 2000. Weeds in the breach. Did substitution resolve a historical over-harvesting issue? *Plantlife* 23: 25, 26.
- CROUCH, N.R., SMITH, G.F. & SMITH, M.T. 2000. *Aptenia cordifolia* (L. f.) Schwantes (Mesembryanthemaceae) in Zulu traditional medicine—an overview. *Haseltonia* 7: 30–36.
- CROUCH, N.R., SMITH, G.F., SYMMONDS, R. & TOMALIN, M. 2000. *Gasteria cranchii*—the magical *impundi* of the Zulu. *British Cactus & Succulent Journal* 18: 70–78.
- CROUCH, N.R. & SYMMONDS, R. 2000. Localising the 'Inanda' provenance of John Medley Wood. *SABONET News* 5: 97–100.
- DE WINTER, B. & GERMISHUIZEN, G. 2000. Obituary: Leslie Edward Wostall Codd (1908–1999). *Bothalia* 30: 111–115.
- DREYER, L.L. & GLEN, R.P. 2000. Nymphaeaceae (Magnoliidae–Nymphaeales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 426.
- DREYER, L.L. & JORDAAN, M. 2000a. Aizoaceae (Caryophyllidae–Caryophyllales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 46–49.
- DREYER, L.L. & JORDAAN, M. 2000b. Brassicaceae (Dilleniidae–Capparales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 184–191.
- DREYER, L.L. & JORDAAN, M. 2000c. Capparaceae (Dilleniidae–Capparales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 204–206.
- DREYER, L.L. & JORDAAN, M. 2000d. Droseraceae (Dilleniidae–Nepenthales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 244, 245.
- DREYER, L.L. & JORDAAN, M. 2000e. Giskiacaceae (Caryophyllidae–Caryophyllales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 314, 315.
- DREYER, L.L. & JORDAAN, M. 2000f. Molluginaceae (Caryophyllidae–Caryophyllales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 410–413.
- DREYER, L.L. & JORDAAN, M. 2000g. Ranunculaceae (Magnoliidae–Ranunculales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 463, 464.
- DREYER, L.L. & MAKWARELA, A.M. 2000a. Crassulaceae (Rosidae–Rosales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 235, 236.
- DREYER, L.L. & MAKWARELA, A.M. 2000b. Geraniaceae (Dilleniidae–Malvales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 312–314.
- DREYER, L.L. & MAKWARELA, A.M. 2000c. Oxalidaceae (Rosidae–Geraniales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 432, 433.
- DUNCAN, G. 2000a. *Eulophia horsfallii* at Kirstenbosch. *Veld & Flora* 86: 16–18.
- DUNCAN, G. 2000b. *Lachenalia* (Hyacinthaceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 99–103.
- EDWARDS, T.J., PATON, A. & CROUCH, N.R. 2000. A new species of *Plectranthus* (Lamiaceae) from Zimbabwe. *Kew Bulletin* 55: 459–464.
- EEN, G. & PEROLD, S.M. 2000. In memory of S.W. Arnell, Hepaticologist (1895–1970). *Bothalia* 30: 218–220.
- FISH, L. 2000a. Commelinaceae (Commelinidae–Commelinales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 591–593.
- FISH, L. 2000b. Poaceae (Gramineae) (Commelinidae–Cyperales/Poales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 659–726.
- GERMISHUIZEN, G. 2000a. Fabaceae (Leguminosae) (Rosidae–Fabales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 262–303.
- GERMISHUIZEN, G. 2000b. Lorantheae (Rosidae–Santalales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 340–344.
- GERMISHUIZEN, G. 2000c. Polygonaceae (Caryophyllidae–Polygonales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 451–453.
- GERMISHUIZEN, G. 2000d. Viscaceae (Rosidae–Santalales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 560, 561.
- GERMISHUIZEN, G. 2000e. Review: Field guide to the acacias of Zimbabwe, by J. Timberlake, C. Fagg & R. Barnes, 1999. *Bothalia* 30: 123, 124.
- GERMISHUIZEN, G. 2000f. Review: A field guide to wild flowers of KwaZulu-Natal and the eastern region, by Elsa Pooley, 1998. *Dendron* 34: 44, 45.
- GERMISHUIZEN, G. 2000g. The mistletoes. *Dendron* 34: 21.
- GERMISHUIZEN, G. 2000h. Abstract of poster: Publications of the National Botanical Institute, South Africa. XVIth AETFAT Congress, 28 August to 2 September 2000. *Scripta Botanica Belgica* 20: 35.
- GERMISHUIZEN, G. & DU PLESSIS, E. 2000. New releases from the National Botanical Institute. *SABONET News* 5: 115, 116.
- GERMISHUIZEN, G. & SCHUTTE, A.L. 2000. *Rhynchosia* (Fabaceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 509, 510.
- GLEN, H.F. 2000a. Arecaceae (Palmae) (Arecidae–Areciales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 580–582.
- GLEN, H.F. 2000b. Cactaceae (Caryophyllidae–Caryophyllales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 197–199.
- GLEN, H.F. 2000c. Cupressaceae (Pinopsida). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 29, 30.
- GLEN, H.F. 2000d. Pinaceae (Pinopsida). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 30.
- GLEN, H.F. 2000e. Podocarpaceae (Pinopsida). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 30, 31.
- GLEN, H.F. 2000f. Stangeriaceae (Cycadopsida). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 31.
- GLEN, H.F. 2000g. Taxodiaceae (Pinopsida). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 31, 32.
- GLEN, H.F. 2000h. Welwitschiaceae (Gnetopsida). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 32.
- GLEN, H.F. 2000i. Zamiaceae (Cycadopsida). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 32, 33.
- GLEN, H.F. 2000j. Primulaceae (Dilleniidae–Primulales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 456, 457.
- GLEN, H.F. 2000k. Review: Rare and threatened plants of KwaZulu-Natal and neighbouring regions, by Rob Scott-Shaw, 1999. *Bothalia* 30: 225.
- GLEN, H.F. 2000l. Review: Taxonomy of cultivated plants, edited by S. Andrews, A. Leslie & C. Alexander, 1999. *Bothalia* 30: 225, 226.
- GLEN, H.F. 2000m. Some notes on making keys that work (at least in theory). *SABONET News* 5: 40–46.
- GLEN, H.F. 2000n. Review: SAPPI tree spotting. Bushveld. *SABONET News* 5: 112–114.
- GLEN, H.F. 2000o. The state of horticultural taxonomy in South Africa. In S. Andrews, A.C. Leslie & C. Alexander, *Taxonomy of cultivated plants*: 469, 470. Third International Symposium, Edinburgh, 20–26 July 1989. Royal Botanic Gardens, Kew.
- GLEN, H.F. & GOLDING, J. 2000. Looking for a new research project? *SABONET News* 5: 38, 39.
- GLEN, H.F. & HARDY, D.S. 2000. Aloaceae (First Part): Aloe. *Flora of southern Africa* 5,1,1. National Botanical Institute, Pretoria.
- GLEN, H.F., MÖSSMER, M. & WILLIS, C. 2000. The paper chase. *SABONET News* 5: 107–112.
- GLEN, H.F. & PEROLD, S.M. 2000. Obituary: Otto Heinrich Volk (1903–2000). *Bothalia* 30: 215–218.
- GLEN, H.F. & VICTOR, J.E. 2000. Myrtaceae (Rosidae–Myrtales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 420–422.
- GLEN, H.F., WEISSER, P.J. & HARDY, D.S. 2001. *Miri yapo ya Venda/Indigenous trees of Venda*. University of Venda, Thohoyandou.
- GLEN, H.F., WILLIS, C. & GOLDING, J. 2000. The paper chase. *SABONET News* 5: 51–56.
- GLEN, R.P. 2000a. Alismataceae (Alismatidae–Alismatales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 567, 568.



- GLEN, R.P. 2000b. Aponogetonaceae (Alismatidae–Najadales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 577, 578.
- GLEN, R.P. 2000c. Cabombaceae (Magnoliidae–Nymphaeales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 197.
- GLEN, R.P. 2000d. Ceratophyllaceae (Magnoliidae–Ceratophyllales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 220, 221.
- GLEN, R.P. 2000e. Cymodoceaceae (Alismatidae–Najadales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 593, 594.
- GLEN, R.P. 2000f. Eriocaulaceae (Commelinidae–Eriocaulales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 607.
- GLEN, R.P. 2000g. Hydrocharitaceae (Alismatidae–Alismatales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 619–621.
- GLEN, R.P. 2000h. Hydrostachyaceae (Asteridae–Callitrichales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 321.
- GLEN, R.P. 2000i. Juncaceae (Commelinidae–Junciales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 639.
- GLEN, R.P. 2000j. Juncaginaceae (Alismatidae–Alismatales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 639, 640.
- GLEN, R.P. 2000k. Lemnaceae (Arecidae–Arales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 640, 641.
- GLEN, R.P. 2000l. Limnocaritaceae (Alismatidae–Alismatales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 642.
- GLEN, R.P. 2000m. Najadaceae (Alismatidae–Najadales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 644.
- GLEN, R.P. 2000n. Podostemaceae (Rosidae–Podostemales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 448, 449.
- GLEN, R.P. 2000o. Pontederiaceae (Liliidae–Haemodorales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 726–728.
- GLEN, R.P. 2000p. Potamogetonaceae (Alismatidae–Najadales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 728.
- GLEN, R.P. 2000q. Prioniaceae (Commelinidae–Junciales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 728, 729.
- GLEN, R.P. 2000r. Ruppiaceae (Alismatidae–Najadales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 733, 734.
- GLEN, R.P. 2000s. Typhaceae (Commelinidae–Typhales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 736.
- GLEN, R.P. 2000t. Xyridaceae (Commelinidae–Commelinales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 737.
- GLEN, R.P. 2000u. Zannichelliaceae (Alismatidae–Alismatales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 738, 739.
- GLEN, R.P. 2000v. Zosteraceae (Alismatidae–Alismatales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 740.
- GLEN, R.P. 2000w. Review: Aquatic and wetland plants of India, by C.D.K. Cook, 1996. *Bothalia* 30: 124.
- GOLDBLATT, P. & BERNHARDT, P. & MANNING, J.C. 2000. Adaptive radiation of pollination mechanisms in *Ixia* (Iridaceae: Crocoideae). *Annals of the Missouri Botanical Garden* 87: 564–577.
- GOLDBLATT, P. & MANNING, J.C. 2000a. Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9. National Botanical Institute and Missouri Botanical Garden.
- GOLDBLATT, P. & MANNING, J.C. 2000b. Iridaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 623–638.
- GOLDBLATT, P. & MANNING, J.C. 2000c. New species of *Moraea* (Iridaceae–Iridoideae) from southern Africa. *Novon* 10: 14–21.
- GOLDBLATT, P. & MANNING, J.C. 2000d. *Wildflowers of the fairest Cape*. Red Roof Design, Cape Town.
- GOLDBLATT, P. & MANNING, J.C. 2000e. The long-proboscid fly pollination system in southern Africa. *Annals of the Missouri Botanical Garden* 87: 146–170.
- GOLDBLATT, P. & MANNING, J.C. 2001. Bobbejaantjies. *Veld & Flora* 87: 12–15.
- GOLDBLATT, P., MANNING, J.C. & BERNHARDT, P. 2000. Adaptive radiation of pollination mechanisms in *Sparaxis* (Iridaceae: Ixioideae). *Adansonia* 22: 57–70.
- GOLDBLATT, P., MANNING, J.C. & BEYERS, J.B.P. 2000a. *Arctotheca* (Asteraceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 303.
- GOLDBLATT, P., MANNING, J.C. & BEYERS, J.B.P. 2000b. *Arctotis* (Asteraceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 303–306.
- GOLDBLATT, P., MANNING, J.C. & BEYERS, J.B.P. 2000c. *Eriocephalus* (Asteraceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 319, 320.
- GOLDBLATT, P., MANNING, J.C. & BEYERS, J.B.P. 2000d. *Haplocarpha*. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 329.
- GOLDBLATT, P., MANNING, J.C. & HERMAN, P.P.J. 2000. *Gymnostephium* (Asteraceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 328, 329.
- GOLDBLATT, P., MANNING, J.C. & HILLIARD, O.M. 2000. *Selago* (Scrophulariaceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 329.
- GOLDBLATT, P., MANNING, J.C. & KOEKEMOER, M. 2000a. *Amphiglossa* (Asteraceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 301, 302.
- GOLDBLATT, P., MANNING, J.C. & KOEKEMOER, M. 2000b. *Stoebe* (Asteraceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 364, 365.
- GOLDBLATT, P., MANNING, J.C. & KOEKEMOER, M. 2000c. *Elytropappus* (Asteraceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 319.
- GOLDBLATT, P., MANNING, J.C. & LINDER, H.P. 2000. Poaceae. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 174–199.
- GOLDBLATT, P., MANNING, J.C. & SNIJMAN, D.A. 2000. Hyacinthaceae. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 93–99.
- GOLDING, J. 2000a. Dealing with DDs: uncertainties and deficiencies in Red Listing. *SABONET News* 5: 28–31.
- GOLDING, J. 2000b. IUCN. The Second World Conservation Congress. *SABONET News* 5: 191–193.
- GOLDING, J. 2000c. Review: 2000 IUCN Red List of threatened species, by C. Hilton-Taylor, 2000. *SABONET News* 5: 205.
- GOLDING, J. 2000d. Picking up the pieces: Red Data Lists in southern Africa. *Bothalia* 30: 213, 214.
- GOLDING, J. 2000e. Southern African Plant Red Data List Workshop. *SABONET News* 5: 23, 24.
- GOLDING, J. & IZIDINE, S. 2000. What? No Red Data List for Mozambique! *Plantlife* 23: 15, 16.
- GOLDING, J., KOBISI, K., MAY, E.D., MOLISE, M., SEPAMO, K., TALUKDAR, S. & THEKO, B. 2000. Red Data List: spotlight on Lesotho. *SABONET News* 5: 96, 97.
- HARDING, W.R., PEROLD, S.M. & GLEN, R.P. 2000. New records from an ephemeral pan, Blouvllei, in Western Cape, South Africa (Hepaticae and Zannichelliaceae). *Bothalia* 30: 157–159.
- HERMAN, P.P.J. 2000a. Die familie Asteraceae: 'n algemene oorsig. *Suid Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie* 19: 66, 67.
- HERMAN, P.P.J. 2000b. Die plantfamilie Asteraceae: 2. Die blomme. *Suid Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie* 19: 118–121.
- HERMANN, P.P.J. 2001. Observations on hairs in the capitula of some southern African Asteraceae genera. *South African Journal of Botany* 67: 65–68.
- HERMAN, P.P.J., RETIEF, E., KOEKEMOER, M. & WELMAN, W.G. 2000. Asteraceae (Compositae) (Asteridae–Asterales). In



- O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 101–170.
- HIGGINS, S.I., BOND, W.J. & TROLLOPE, W.S.W. 2000. Fire, resprouting and variability: a recipe for grass–tree coexistence in savanna. *Journal of Ecology* 88: 213–229.
- HITCHCOCK, A. 2000. Living plant collections. Kirstenbosch National Botanical Garden. *SABONET News* 5: 173–181.
- HOARE, D.B., VICTOR, J.E., LUBKE, R.A. & MUCINA, L. 2000. Vegetation of the coastal fynbos and rocky headlands south of George, South Africa. *Bothalia* 30: 87–96.
- HONIG, M. 2000. *Making your garden come alive! Environmental interpretation in botanical gardens*. SABONET Report No. 9. National Botanical Institute, Pretoria.
- JOFFE, P. 2000. *Keep the Lowveld green!* Environmental Resource Guide: Greening SA 7. National Botanical Institute, Pretoria.
- JORDAAN, M. 2000a. Amaranthaceae (Caryophyllidae–Caryophyllales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 49–56.
- JORDAAN, M. 2000b. Annonaceae (Magnoliidae–Magnoliales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 59–62.
- JORDAAN, M. 2000c. Aristolochiaceae (Magnoliidae–Aristolochiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 100, 101.
- JORDAAN, M. 2000d. Balanophoraceae (Rosidae–Santalales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 172.
- JORDAAN, M. 2000e. Basellaceae (Caryophyllidae–Caryophyllales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 173, 174.
- JORDAAN, M. 2000f. Cannabaceae (Dilleniidae–Urticales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 203.
- JORDAAN, M. 2000g. Caryophyllaceae (Caryophyllidae–Caryophyllales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 206–213.
- JORDAAN, M. 2000h. Casuarinaceae (Hamamelidae–Casuarinales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 213.
- JORDAAN, M. 2000i. Chenopodiaceae (Caryophyllidae–Caryophyllales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 221–226.
- JORDAAN, M. 2000j. Connaraceae (Rosidae–Rosales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 229, 230.
- JORDAAN, M. 2000k. Cunoniaceae (Rosidae–Rosales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 241, 242.
- JORDAAN, M. 2000l. Escalloniaceae (Rosidae–Rosales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 249.
- JORDAAN, M. 2000m. Fagaceae (Hamamelidae–Fagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 303, 304.
- JORDAAN, M. 2000n. Fumariaceae (Magnoliidae–Papaverales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 308, 309.
- JORDAAN, M. 2000o. Grubbiaceae (Dilleniidae–Ericales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 316.
- JORDAAN, M. 2000p. Hamamelidaceae (Hamamelidae–Hamamelidales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 318.
- JORDAAN, M. 2000q. Hernandiaceae (Magnoliidae–Magnoliales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 318, 319.
- JORDAAN, M. 2000r. Hydnoraceae (Magnoliidae–Aristolochiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 319, 320.
- JORDAAN, M. 2000s. Lauraceae (Magnoliidae–Magnoliales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 334–336.
- JORDAAN, M. 2000t. Monimiaceae (Magnoliidae–Magnoliales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 414.
- JORDAAN, M. 2000u. Montiniaceae (Rosidae–Rosales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 414, 415.
- JORDAAN, M. 2000v. Moraceae (Hamamelidae–Urticales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 415, 416.
- JORDAAN, M. 2000w. Moringaceae (Dilleniidae–Capparidales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 417.
- JORDAAN, M. 2000x. Myricaceae (Hamamelidae–Juglandales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 418.
- JORDAAN, M. 2000y. Myrothamnaceae (Hamamelidae–Hamamelidales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 418, 419.
- JORDAAN, M. 2000z. Neuradaceae (Dilleniidae–Malvales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 423.
- JORDAAN, M. 2000za. Nyctaginaceae (Caryophyllidae–Caryophyllales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 424–426.
- JORDAAN, M. 2000zb. Olacaceae (Rosidae–Santalales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 427, 428.
- JORDAAN, M. 2000zc. Opiliaceae (Rosidae–Santalales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 431, 432.
- JORDAAN, M. 2000zd. Papaveraceae (Magnoliidae–Ranunculales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 433, 434.
- JORDAAN, M. 2000ze. Phytolaccaceae (Caryophyllidae–Caryophyllales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 442–444.
- JORDAAN, M. 2000zf. Piperaceae (Magnoliidae–Piperales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 444, 445.
- JORDAAN, M. 2000zg. Pittosporaceae (Rosidae–Rosales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 445, 446.
- JORDAAN, M. 2000zh. Portulacaceae (Caryophyllidae–Caryophyllales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 453–456.
- JORDAAN, M. 2000zi. Rafflesiaceae (Magnoliidae–Aristolochiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 462.
- JORDAAN, M. 2000zj. Resedaceae (Dilleniidae–Capparidales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 464, 465.
- JORDAAN, M. 2000zk. Roridulaceae (Dilleniidae–Ericales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 470.
- JORDAAN, M. 2000zl. Rosaceae (Rosidae–Rosales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 470–476.
- JORDAAN, M. 2000zm. Salicaceae (Dilleniidae–Violales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 499–501.
- JORDAAN, M. 2000zn. Ulmaceae (Dilleniidae–Urticales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 550, 551.
- JORDAAN, M. 2000zo. Urticaceae (Dilleniidae–Urticales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 552–555.
- JORDAAN, M. 2000zp. Vahliaaceae (Rosidae–Rosales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 556.
- JORDAAN, M. & BURGOYNE, P. 2000. Santalaceae (Rosidae–Santalales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 501–503.
- JORDAAN, M. & VAN WYK, A.E. 2000. Systematic studies in subfamily Celastraceae (Celastraceae) in southern Africa: two new species of *Gymnosporia* from KwaZulu-Natal and the Eastern Cape. *South African Journal of Botany* 66: 10–14.
- KILLICK, D.J.B. 2000. Obituary: Rosemary Charlotte Holcroft (1942–2000). *Bothalia* 30: 221–223.
- KOEKEMOER, M. 2000. Abstract: The Metasia group (Gnaphalieae—Relbaniaceae, Asteraceae). XVth AETFAT Congress, 28 August to 2 September 2000. *Scripta Botanica Belgica* 20: 45.
- KOEKEMOER, M. & FISH, L. 2000. Abstract of poster: Exploration in southern Africa—analysis from herbarium records. XVth AETFAT Congress, 28 August to 2 September 2000. *Scripta Botanica Belgica* 20: 45.

- KOORBANALLY, N.A., MULHOLLAND, D.A. & CROUCH, N.R. 2000a. Alkaloids and triterpenoids from *Ammocharis coranica* (Amaryllidaceae). *Phytochemistry* 54: 93–97.
- KOORBANALLY, N.A., MULHOLLAND, D.A. & CROUCH, N.R. 2000b. Isolation of isovanillin from aromatic roots of the medicinal African liane, *Mondia whitei*. *Journal of Herbs, Spices & Medicinal Plants* 7.3: 37–43.
- KURZWEIL, H. 2000a. Orchidaceae. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 155–174.
- KURZWEIL, H. 2000b. Orchidaceae (Liliidae–Orchidales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 644–659.
- KURZWEIL, H. 2000c. The value of early floral ontogeny in the systematics of Orchidaceae. In K.L. Wilson & D.A. Morrison, *Monocots: systematics and evolution*: 436–440. CSIRO, Melbourne.
- KURZWEIL, H. 2001. Notes on the botany of Mt Kinabalu (Malaysia). *Mountain Club of South Africa Journal* 1999.
- KURZWEIL, H. & LINDER, H.P. 2001. Tribe Disceae (Orchidaceae). In A. Pridgeon, P.J. Cribb, M. Chase & F.N. Rasmussen, *Genera Orchidacearum* 2: 11–58. Oxford University Press.
- KURZWEIL, H. & LINDER, H.P. 2001a. *Dracomonticola* (Orchidaceae). In A. Pridgeon, P.J. Cribb, M. Chase & F.N. Rasmussen, *Genera Orchidacearum* 2: 288–290. Oxford University Press.
- KURZWEIL, H. & LINDER, H.P. 2001b. *Neobolusia* (Orchidaceae). In A. Pridgeon, P.J. Cribb, M. Chase & F.N. Rasmussen, *Genera Orchidacearum* 2: 317–319. Oxford University Press.
- KURZWEIL, H. & SMITH, G.F. 2000. Les Orchidées succulentes d'Afrique du Sud: un synopsis mis à jour (1). *Succulentes (France)* 23.4: 24–32.
- LEISTNER, O.A. (ed.) 2000. Seed plants of southern Africa: families and genera. *Strelitzia* 10.
- LEISTNER, O.A. & BREDENKAMP, C.L. 2000. Malvaceae (Dilleniidae–Malvales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 347–352.
- LEPSCHI, B.J. & MANNING, J.C. 2000. A taxonomic review of the naturalized species of *Babiana* (Iridaceae) occurring in Western Australia. *Nuytsia* 13: 283–292.
- LINDER, H.P. & KURZWEIL, H. 2001. *Schizochilus* (Orchidaceae). In A. Pridgeon, P.J. Cribb, M. Chase & F.N. Rasmussen, *Genera Orchidacearum* 2: 361–364. Oxford University Press.
- LÖTTER, M., AUBREY, A., DOBSON, L. & EYSSEL, A. 2000. Plant collecting expedition on Blyde River Canyon Nature Reserve. *Plantlife* 23: 12–14.
- MALCOLM, N. 2000. What's new at the National Botanical Institute? *Veld & Flora* 86: 58.
- MANNING, J.C. 2000a. A new combination in *Eriospermum* (Convallariaceae). *Bothalia* 30: 157.
- MANNING, J.C. 2000b. Rising from the ashes. *African—Environment & Wildlife* 8: 24.
- MANNING, J.C. 2000c. Diamonds in the dust. *African—Environment & Wildlife* 8: 30.
- MANNING, J.C. & PATERSON-JONES, C. 2000. Seeing red. Birds and the flowers they pollinate. *Africa—Birds & Birding*: 40–49.
- MANNING, J.C. & SMITH, G.F. 2000. The genus *Poellnitzia* included in *Astroloba* (Asphodelaceae: Aloolioideae). *Bothalia* 30: 53.
- MCDONALD, D.J. 2000. Floral secrets of the Bontebok National Park. *Veld & Flora* 86: 70–72.
- MCDONALD, D.J., BOUCHER, C. & OLIVER, E.G.H. 2000. Obituary: Hugh Colin Taylor (1925–1999). *Bothalia* 30: 115–119.
- MEEROW, A.W., FAY, M.F., CHASE, M.W., GUY, C.L., LI, Q.-B., SNIJMAN, D.A. & YANG, S.-Y. 2000. Phylogeny of Amaryllidaceae: molecules and morphology. In K. Wilson & D. Morrison, *Proceedings of the Second International Symposium on the Comparative Biology of the Monocotyledons*: 368–382. CSIRO Press, Sydney.
- MEYER, N.L. 2000a. Alliaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 569, 570.
- MEYER, N.L. 2000b. Anthericaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 576, 577.
- MEYER, N.L. 2000c. Asparagaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 582.
- MEYER, N.L. 2000d. Colchicaceae (Liliidae–Liliales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 587–590.
- MEYER, N.L. 2000e. Eriospermaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 607, 608.
- MEYER, N.L. 2000f. Liliaceae (Liliidae–Liliales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 642.
- MEYER, N.L. 2000g. Luzuriagaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 643.
- MEYER, N.L. 2000h. Smilacaceae (Liliidae–Dioscoreales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 734.
- MEYER, N.L. & ARCHER, R.H. 2000. Agapanthaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 566.
- MEYER, N.L. & SMITH, G.F. 2000. *Astroloba* (Asphodelaceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 66, 67.
- MIDGLEY, G., ASHWELL, A., RUTHERFORD, M., BOND, W. & HANNAH, L. 2000. Peace Parks Foundation Review: Beyond boundaries. Climate change in southern Africa. *Africa—Environment & Wildlife*: 26–29.
- MOMBERG, B.A. 2000. Compiler: National Botanical Institute South Africa: administration and research staff 31 March 2000, publications 1 April 1999–31 March 2000. *Bothalia* 30: 229–242.
- MÖSSMER, M. 2000. From the web. *SABONET News* 5: 100, 101.
- MÖSSMER, M. & WILLIS, C.K. 2000a. Review: Plant taxonomic expertise. An inventory for southern Africa. *SABONET News* 5: 83, 84.
- MÖSSMER, M. & WILLIS, C.K. 2000b. *Plant taxonomic expertise. An inventory for southern Africa*. SABONET Report No. 10. National Botanical Institute, Pretoria.
- NGWENYA, M.A. 2000. Myrsinaceae (Dilleniidae–Primulales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 419, 420.
- O'CALLAGHAN, M. 2000. National grid of vegetation sites: reality check. *South African Journal of Science* 96: 231–233.
- OLIVER, E.G.H. 2000a. Ericaceae (Dilleniidae–Ericales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 246–248.
- OLIVER, E.G.H. 2000b. Systematics of *Erica* (Ericaceae–Ericaceae): species with indehiscent and partially dehiscent fruits. *Contributions from the Bolus Herbarium* 19. University of Cape Town & National Botanical Institute.
- OLIVER, E.G.H. 2000c. Southern African herbaria. Compton Herbarium (NBG). *SABONET News* 5: 194–196.
- OLIVER, E.G.H. & OLIVER, I.M. 2000a. Two new species of *Erica* from Western Cape, South Africa (Ericaceae). *Bothalia* 30: 49–53.
- OLIVER, E.G.H. & OLIVER, I.M. 2000b. Three new species of *Erica* (Ericaceae) from Western Cape, South Africa. *Bothalia* 30: 147–153.
- OLIVER, E.G.H. & OLIVER, I.M. 2000c. Ericaceae. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 423–452.
- OLIVER, E.G.H. & OLIVER, I.M. 2001a. The ultimate prize—a new species of *Erica*. *Yearbook of the Heather Society* 2001: 9–14.
- OLIVER, E.G.H. & OLIVER, I.M. 2001b. Taxonomic problems in the *Erica filipendula* complex. *Yearbook of the Heather Society* 2001: 39–46.
- OLIVER, I. 2000. A unique desert garden in the winter rainfall area of South Africa. *Aloe* 37: 28–30.
- OLIVER, I. & OLIVER, T. (E.G.H.) 2000. *Field guide to the Ericas of the Cape Peninsula*. Protea Atlas Project, National Botanical Institute, Cape Town.
- PEROLD, S.M. 2000a. Studies in the Sphacrocarpales (Hepaticae) from southern Africa. 2. The genus *Sphaerocarpos* and its only local species, *S. stipitatus*. *Bothalia* 30: 17–24.
- PEROLD, S.M. 2000b. Studies in the Sphacrocarpales (Hepaticae) from southern Africa. 3. The genus *Riella* and its local species. *Bothalia* 30: 125–142.
- POHL, T.S., CROUCH, N.R. & MULHOLLAND, D.A. 2000. Southern African Hyacinthaceae: chemistry, bioactivity and ethnobotany. *Current Organic Chemistry* 4:1287–1324.
- REBELO, A.G. (ed.). 2000. *Interim distribution map, KwaZulu-Natal*, edn 2. Protea Atlas Project, National Botanical Institute, Cape Town.
- REBELO, A.G. (ed.). 2001a. *Interim distribution map, Cape*, edn 3, vol. 1: *sugarbushes, grevilleoids and allies*. Protea Atlas Project, National Botanical Institute, Cape Town.



- REBELO, A.G. (ed.). 2001b. *Interim distribution map, Cape*, edn 3, vol. 2: *pincushions and allies*. Protea Atlas Project, National Botanical Institute, Cape Town.
- REBELO, A.G. (ed.). 2001c. *Interim distribution map, Cape*, edn 3, vol. 3: *conebushes*. Protea Atlas Project, National Botanical Institute, Cape Town.
- REBELO, A.G. (ed.). 2001d. *Interim distribution map, northern provinces*. Protea Atlas Project, National Botanical Institute, Cape Town.
- REBELO, A.G. & REBELO, P. (eds). 2000a. *Interim distribution map, Zimbabwe*, edn 2. Protea Atlas Project, National Botanical Institute, Cape Town.
- REBELO, A.G. & REBELO, P. 2000b. *Protea Atlas Newsletter* 46. Protea Atlas Project, Kirstenbosch, Cape Town.
- REBELO, A.G. & REBELO, P. 2000c. *Protea Atlas Newsletter* 47. Protea Atlas Project, Kirstenbosch, Cape Town.
- REBELO, A.G. & REBELO, P. 2000d. *Protea Atlas Newsletter* 48. Protea Atlas Project, Kirstenbosch, Cape Town.
- REBELO, A.G. & REBELO, P. 2000e. *Protea Atlas Newsletter* 49. Protea Atlas Project, Kirstenbosch, Cape Town.
- REBELO, A.G. & REBELO, P. 2001. *Protea Atlas Newsletter* 50. Protea Atlas Project, Kirstenbosch, Cape Town.
- RETIEF, E. 2000a. Avicenniaceae (Asteridae–Lamiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 171.
- RETIEF, E. 2000b. Boraginaceae (Asteridae–Lamiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 178–183.
- RETIEF, E. 2000c. Hydrophyllaceae (Asteridae–Solanales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 320, 321.
- RETIEF, E. 2000d. Lamiaceae (Labiatae) (Asteridae–Lamiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 323–334.
- RETIEF, E. 2000e. Verbenaceae (Asteridae–Lamiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 557–559.
- RETIEF, E. 2000f. Vitaceae (Rosidae–Rhamnales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 561, 562.
- RETIEF, E. 2000g. Zygophyllaceae (Rosidae–Sapindales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 563–565.
- RETIEF, E. 2000h. Review: *Oxyanthus* (Rubiaceae–Gardenieae–Gardeniinae) en Afrique Centrale: étude systématique, by B. Sonké. *Bothalia* 30: 226, 227.
- RETIEF, E. & BUYS, M.H. 2000a. Boraginaceae. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 374, 375.
- RETIEF, E. & BUYS, M.H. 2000b. *Trichodesma* (Boraginaceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 377.
- RETIEF, E. & LEISTNER, O.A. 2000. Rubiaceae (Asteridae–Rubiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 476–495.
- RETIEF, E. & VAN WYK, A.E. 2000a (1999). Ehretiaceae versus Boraginaceae: evidence from palynology. Proceedings of the 4th Symposium on African Palynology, Sousse, Tunisia, 25–30 April 1999. *Geo-Eco-Trop*, Special issue 22: 209–219.
- RETIEF, E. & VAN WYK, A.E. 2000b (1999). The taxonomic significance of pollen morphology in the southern African Boraginaceae. In J. Timberlake & S. Katiya, *African plants: biodiversity, taxonomy and uses*: 319–329. Royal Botanic Gardens, Kew.
- ROURKE, J.P. 2000a. Proteaceae (Rosidae–Proteales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 457–461.
- ROURKE, J.P. 2000b. Stilbaceae (Asteridae–Lamiales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 541–543.
- ROURKE, J.P. 2000c. A review of generic concepts in the Stilbaceae. *Bothalia* 30: 9–15.
- ROURKE, J.P. 2000d. Plant systematics in South Africa. A brief historical overview, 1753–1953. *Transactions of the Royal Society of South Africa* 54: 179–190.
- ROUX, J.P. 2000a. Pteridophytes, ferns and fern-allies. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 37–50, 691, 692.
- ROUX, J.P. 2000b. A new combination and new records for the *Flora of Malawi* (Pteridophyta). *Bothalia* 30: 155, 156.
- ROUX, J.P. 2000c. The genus *Polystichum* (Dryopteridaceae) in Africa. *Bulletin of the Natural History Museum, London* (Botany) 30: 33–79.
- ROUX, J.P. & VAN WYK, A.E. 2000. Morphology and anatomy of the rhizome and frond in the African species of *Polystichum* (Pteropsida: Dryopteridaceae). *Bothalia* 30: 57–68.
- SIEBERT, S.J. 2000. Editorial. *SABONET News* 5: 135.
- SIEBERT, S.J. & GLEN, H.F. 2000. The paper chase. *SABONET News* 5: 198–202.
- SIEBERT, S.J. & WILLIS, C.K. 2000a. Computerisation of southern African herbaria: a regional update. *SABONET News* 5: 182–184.
- SIEBERT, S.J. & WILLIS, C.K. 2000b. The Southern African Botanical Diversity Network (SABONET). *The Bridge* 1,7: 10, 11.
- SIMMONS, M.P., CLEVERINGER, C.C., SAVOLAINEN, V.V., ARCHER, R.H., MATHEWS, S. & DOYLE, J.J. 2001. Phylogeny of the Celastraceae inferred from phytochrome B gene sequence and morphology. *American Journal of Botany* 88: 313–325.
- SINGH, Y. 2000a. Acoraceae (Arecidae–Arales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 566.
- SINGH, Y. 2000b. Araceae (Arecidae–Arales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 578–580.
- SINGH, Y. 2000c. IUBS—advancing biology in the 21st century. *SABONET News* 5: 161, 162.
- SINGH, Y. & BAJINATH, H. 2000. Abstract of poster: species diversity in southern African *Hypoxis* (Hypoxidaceae). XVIth AET-FAT Congress, 28 August to 2 September 2000. *Scripta Botanica Belgica* 20: 83.
- SMITH, G.F. 2000a. Golden age of disseminating information on *Haworthia*. In I. Breuer, *World of Haworthias*, Vol. 2: viii, ix. Ingo Breuer & Arbeitskreis für Mammillarienfreunde e. V. (Afm), Niederzier & Homburg/Saar.
- SMITH, G.F. 2000b. *Repertorium Plantarum Succulentarum*: a mainstay of the International Organization for Succulent Plant Study. *Repertorium Plantarum Succulentarum* 50: 3. International Organization for Succulent Plant Study, Zürich.
- SMITH, G.F. 2000c. Geographical corrections to the ISI 2000 plant distribution list: *Aloe wickensii* and *Haworthia venosa* subsp. *wooleyi*. *Haworthiad* 14: 121, 122.
- SMITH, G.F. 2000d. Message from the President. *IOS Bulletin* 8: 1–3.
- SMITH, G.F. 2000e. Triennial report on activities of the International Organization for Succulent Plant Study (IOS): 1997–2000. *IOS Bulletin* 8: 30–33.
- SMITH, G.F. 2000f. Succulents in the Missouri Botanical Garden. *British Cactus & Succulent Journal* 18: 201–205.
- SMITH, G.F. 2000g. Simply systematics: succulent plant studies into the new millennium. *IOS Bulletin* 8: 26, 27.
- SMITH, G.F. 2000h. Goodbye (but not farewell), Chris. Your big heart will be missed. *SABONET News* 5: 138.
- SMITH, G.F. 2000i. A memorable occasion: the 16th International Botanical Congress. *SABONET News* 5: 19–22.
- SMITH, G.F. 2000j. An African workshop on the Global Taxonomy Initiative. *SABONET News* 5: 154.
- SMITH, G.F. 2000k. Agavaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 567.
- SMITH, G.F. 2000l. Asphodelaceae: *Aloe*. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 64–66.
- SMITH, G.F. 2000m. Further developments in the Species Plantarum: Flora of the World project. *South African Journal of Science* 96: 482, 483.
- SMITH, G.F. & MEYER, N.L. 2000. Asphodelaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 582–586.
- SMITH, G.F. & RAPER, I. 2000. Producing *South African Journal of Botany*: current realities and future perspectives. *South African Journal of Botany* 66: 2–6.
- SMITH, G.F. & STEYN, E.M.A. 2000. Obituary: Barbara Joan Jeppe (1921–1999): botanical artist extraordinaire. *Bothalia* 30: 119–122.
- SMITH, G.F., STEYN, E.M.A. & VAN WYK, A.E. 2001. *Crassula tetragona* subsp. *acutifolia* (Crassulaceae). *Curtis's Botanical Magazine* 18: 23–27.
- SMITH, G.F., STEYN, E.M.A., VICTOR, J.E., CROUCH, N.R., GOLDING, J. & HILTON-TAYLOR, C. 2000. The conservation status of *Aloe* in South Africa: an updated synopsis (Aloaceae). *Bothalia* 30: 207–211.



- SMITH, G.F., VAN WYK, B.-E., STEYN, E.M.A. & BREUER, I. 2000. Classification of *Haworthia*: perspectives from nectar sugar analysis and morphology. *Scripta Botanica Belgica* 20: 84.
- SMITH, G.F., ZIETSMAN, P.C., STEYN, E.M.A. & BREUER, I. 2000. The distribution of *Haworthia venosa* subsp. *tessellata* in southern Africa. *Haworthiad* 14: 40–43.
- SMITHIES, S.J. 2000a. Bignoniaceae (Asteridae–Scrophulariales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 175–178.
- SMITHIES, S.J. 2000b. Gesneriaceae (Asteridae–Scrophulariales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 314.
- SMITHIES, S.J. 2000c. Lentibulariaceae (Asteridae–Scrophulariales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 336, 337.
- SMITHIES, S.J. 2000d. Pedaliaceae (Asteridae–Scrophulariales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 436–440.
- SMITHIES, S.J. 2000e. Scrophulariaceae (Asteridae–Scrophulariales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 508–537.
- SNIJMAN, D.A. 2000a. Agapanthaceae. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 52.
- SNIJMAN, D.A. 2000b. Alliaceae. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 52.
- SNIJMAN, D.A. 2000c. Amaryllidaceae. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 53–60.
- SNIJMAN, D.A. 2000d. Amaryllidaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 570–576.
- SNIJMAN, D.A. 2000e. Hypoxidaceae. In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 108–110.
- SNIJMAN, D.A. 2000f. Hypoxidaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 621–623.
- STEINER, K. 2000a. *Colpias* (Scrophulariaceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 645.
- STEINER, K. 2000b. *Diascia* (Scrophulariaceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 645–648.
- STEINER, K. 2000c. *Heuimeris* (Scrophulariaceae). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 651, 652.
- STEYN, E.M.A. & SMITH, G.F. 2000. *Agave vivipara*: a naturalized alien in southern Africa (Agavaceae). *Bothalia* 30: 43–46.
- STEWART, A., BROWN, N.A.C. & DIXON, K. 2000 (1999). Smoke and seed germination. In *Let's propagate. A plant propagation manual for Australia*: 171–184. ABC Books, Australian Broadcasting Corporation, Sydney.
- SWARTZ, P. 2000. Woude en hul omringende grasvelde. Deel 2: Ngome, plek van die skaduwee. *Veld & Flora* 86: 67–69.
- SYMONDS, A. 2000. Teacher capacity building: skills development through environmental education. *Roots* 20: 25–28.
- TARR, B. 2000. The great yellow *Clivia* jigsaw puzzle. *Clivia Yearbook* 2: 10–12.
- THORNELL, K., VEDAVATHY, S., MULHOLLAND, D.A. & CROUCH, N.R. 2000. Parallel usage patterns of African and Indian periplocoids corroborate phenolic root chemistry. *Southern African Ethnobotany* 1,2: 17–22.
- VAN DER WALT, L. 2000. Hanging gardens at Kirstenbosch. *Veld & Flora* 86: 38.
- VAN JAARSVELD, E. 2000a. Indigenous fish for a garden pond. *Veld & Flora* 86: 36, 37.
- VAN JAARSVELD, E. 2000b. *Saphesia flaccida*—a conservation status update. *British Cactus & Succulent Journal* 18: 108, 109.
- VAN JAARSVELD, E. 2000c. Review: *Pochypodium* (Apocynaceae), taxonomy habitats and cultivation, by S.H.J.V. Rapanarivo *et al.* *Veld & Flora* 86: 192.
- VAN JAARSVELD, E. 2000d. *Welwitschia mirabilis*. *Veld & Flora* 86: 176–179.
- VAN JAARSVELD, E. 2000e. *Waterbesparende inheemse tuinaak*. Tafelberg, Kaapstad.
- VAN JAARSVELD, E. 2000f. *Wonderful waterwise gardening*. Tafelberg, Cape Town.
- VAN JAARSVELD, E. & VAN WYK, B.-E. 2000. South African and Namibian succulents on the edge: the cliff face home. *Aloe* 37: 88–90.
- VAN JAARSVELD, E., VAN WYK, B.-E. & SMITH, G.F. 2000. *Succulents of South Africa. A guide to the regional diversity*. Tafelberg, Cape Town.
- VAN ROOY, J. 2000. Introduction to bryology in southern Africa. 8. Moss diversity and endemism. *Plantlife* 23: 31, 32.
- VAN STADEN, J., BROWN, N.A.C., JÄGER, A.K. & JOHNSON, T.A. 2000. Smoke as a germination cue. *Plant Species Biology* 15: 167–178.
- VAN WYK, E., CILLIERS, S.S. & BREDEKAMP, G.J. 2000. Vegetation analysis of wetlands in the Klerksdorp Municipal Area, North West Province, South Africa. *South African Journal of Botany* 66: 52–62.
- VAN WYK, E. & HURTER, J. 2000. *Brachystegia spiciformis*. An exciting discovery. *SABONET News* 5: 170–172.
- VICTOR, J.E. 2000a. Buddlejaceae (Asteridae–Gentianales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 195, 196.
- VICTOR, J.E. 2000b. Heteropyxidaceae (Rosidae–Myrtales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 319.
- VICTOR, J.E. 2000c. Oleaceae (Asteridae–Scrophulariales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 428, 429.
- VICTOR, J.E. 2000d. Rutaceae (Rosidae–Sapindales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 495–499.
- VICTOR, J.E. 2000e. Strychnaceae (Asteridae–Gentianales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 543.
- VICTOR, J.E. 2000f (1999). What's happening in the Asclepiadaceae. In J. Timberlake & S. Kativu, *African plants: biodiversity, taxonomy and uses*: 339. Royal Botanic Gardens, Kew.
- VICTOR, J.E., BREDEKAMP, C.L., VENTER, H.J.T., BRUYNS, P.V. & NICHOLAS, A. 2000. Apocynaceae (Asteridae–Gentianales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 71–98.
- VICTOR, J.E., HOARE, D.B. & LUBKE, R.A. 2000. Checklist of plant species of the coastal fynbos and rocky headlands, south of George, South Africa. *Bothalia* 30: 97–101.
- VICTOR, J.E. & VAN WYK, A.E. 2000 (1999). Pollen morphology of *Phyllosma* and *Sheilanthra* (Diosminae: Rutaceae) and its taxonomic implications. *Grana* 39: 103–107.
- WELMAN, W.G. 2000a. National Botanical Institute Garden Festival, 17 October 1998. *Dendron* 34: 25.
- WELMAN, W.G. 2000b. National Botanical Garden, outing of Magalies Branch, 28 June 1998. *Dendron* 34: 36–38.
- WELMAN, W.G. 2000c. Campanulaceae (Asteridae–Asterales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 200–202.
- WELMAN, W.G. 2000d. Convolvulaceae (Asteridae–Solanales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 231–234.
- WELMAN, W.G. 2000e. Cucurbitaceae (Dilleniidae–Violales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 237–241.
- WELMAN, W.G. 2000f. Dipsacaceae (Asteridae–Dipsacales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 243.
- WELMAN, W.G. 2000g. Goodeniaceae (Asteridae–Campanulales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 315.
- WELMAN, W.G. 2000h. Lobeliaceae (Asteridae–Asterales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 339, 340.
- WELMAN, W.G. 2000i. Myoporaceae (Asteridae–Scrophulariales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 417.
- WELMAN, W.G. 2000j. Plantaginaceae (Asteridae–Plantaginales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 446.
- WELMAN, W.G. 2000k. *Solanum* (Solanales). In P. Goldblatt & J.C. Manning, Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* 9: 673–675.
- WELMAN, W.G. 2000l. Solanaceae (Asteridae–Solanales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 537–539.

- WELMAN, W.G. 2000m. Sphenocleaceae (Asteridae–Asterales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 539.
- WELMAN, W.G. 2000n. Valerianaceae (Asteridae–Dipsacales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 556, 557.
- WELMAN, W.G. 2000o. FSA contributions 16: Sphenocleaceae. *Bothalia* 30: 31–33.
- WELMAN, W.G. 2000p. The Vth International Solanaceae Conference, 23–28 July 2000. *SABONET News* 5: 155–160.
- WILLIAMS, R. 2000. Hyacinthaceae (Liliidae–Asparagales). In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 610–619.
- WILLIS, C. 2000a. Amongst Africa's giants. Botanical notes from a journey to Mount Kilimanjaro. *Veld & Flora* 86: 162–167.
- WILLIS, C. 2000b. Editorial. *SABONET News* 5: 2, 3.
- WILLIS, C. 2000c. Editorial. *SABONET News* 5: 78, 79.
- WILLIS, C. 2000d. Southern African botanical gardens needs assessment published. *SABONET News* 5: 185–190.
- WILLIS, C., BURROWS, J.E., PHIRI, P.S.M., KAMUNDI, D.A.I., CHIKUNI, A. & GOLDING, J. 2000. Abstract: Developing a greater understanding of the flora of the Nyika. XVIth AETFAT Congress, 28 August to 2 September 2000. *Scripta Botanica Belgica* 20:
- WILLIS, C., BURROWS, J. & WINTER, P. 2000. SABONET Nyika Expedition 2000. *SABONET News* 5: 5–14.
- WILLIS, C.K. & HUNTLEY, B.J. 2000. Abstract: SABONET: developing capacity within southern Africa's herbaria and botanical gardens. XVIth AETFAT Congress, 28 August to 2 September 2000. *Scripta Botanica Belgica* 20: 94.
- WILLIS, C.K. & MÖSSMER, M. (eds). 2000a. *SABONET News* 5,1.
- WILLIS, C.K. & MÖSSMER, M. (eds). 2000b. *SABONET News* 5,2.
- WINTER, J. 2000. The natural distribution and ecology of *Clivia*. *Clivia Yearbook* 2: 5–9.





## Guide for authors to *Bothalia*

This guide is updated when necessary and includes an index. **Important points and latest additions appear in bold type.**

*Bothalia* is named in honour of General Louis Botha, first Premier and Minister of Agriculture of the Union of South Africa. This house journal of the National Botanical Institute, Pretoria, is devoted to the furtherance of botanical science. The main fields covered are taxonomy, ecology, anatomy and cytology. Two parts of the journal and an index to contents, authors and subjects are published annually.

### 1 Editorial policy

1.1 *Bothalia* welcomes original papers dealing with flora and vegetation of southern Africa and related subjects. Full-length papers and short notes, as well as book reviews and obituaries of botanists, are accepted. **The editor should be notified that an article is part of a series of MSS; please submit a list of the parts of a series; all parts should preferably be published in one journal.**

1.2 **Submission of a manuscript to *Bothalia* implies that it has not been published previously and is not being considered for publication elsewhere.**

1.3 **Authors whose first language is not English are requested to have their MS edited by an English speaker before submission.**

1.4 Articles are assessed by referees, both local and overseas. Authors are welcome to suggest possible referees to judge their work. Authors are responsible for the factual correctness of their contributions. *Bothalia* maintains an editorial board (see title page) to ensure that international standards are upheld.

1.5 **Page charges:** as stated in our notification included in volume 23,1 (May 1993), MSS submitted for publication in *Bothalia* are subject to payment of page charges of R125,00 per printed page, VAT included. The following are exempt from these charges: 1, NBI members; 2, persons/institutions who have been granted exemption by the Executive Committee of the NBI; 3, authors of contributions requested by the Editor; 4, contributors to the column 'FSA contributions'. The Editor's decision on the number of pages is final. An invoice will be sent to the author, who must arrange for payment as soon as possible to NBI, Publications Section, Private Bag X101, Pretoria 0001.

### 2 Requirements for a manuscript

2.1 The original manuscript should be typed on one side of A4-size paper, double line spacing throughout (including abstract, tables, captions to figures, literature references, etc.) and have a margin of at least 30 mm all round. **Three photocopies (all pages photocopied on both sides of the paper, including figures, to reduce weight for postage)** of all items, including text, line drawings, tables and lists should be submitted, and the

author should retain a complete set of copies. **Three photographs (or high quality photocopies) of each photograph/photograph mosaic should be submitted for review purposes.** The electronic version should be submitted with the final (accepted) manuscript (see 3).

2.2 Papers should conform to the general style and layout of recent issues of *Bothalia* (from volume 26 onwards).

2.3 Material should be presented in the following sequence: Title page with title, name(s) of author(s), keywords, abstract (and information that should be placed in a footnote on the title page, such as address(es) of author(s) and mention of granting agencies).

2.4 The sequence continues with Introduction and aims, Contents (see 8), Material and methods, Results, Interpretation (Discussion), Specimens examined (in revisions and monographs), Acknowledgements, References, Index of names (recommended for revisions dealing with more than about 15 species), Tables, Captions for figures and figures. In the case of short notes, obituaries and book reviews, keywords and abstract are superfluous.

2.5 **All pages must be numbered** consecutively beginning with the title page to those with references, tables, captions for figures and figures.

2.6 Special characters: use your own word or code that is unique and self-explanatory, enclosed between ANGLE BRACKETS, e.g. <mu>m for µm. Please supply us with a list of the codes.

2.7 Use a **non-breaking space** (in MS Word—Ctrl, shift, space) to keep two elements together on the same line, e.g. 3 500.

2.8 **DO NOT JUSTIFY LINES.**

2.9 Do not break words, except hyphenated words.

2.10 A hyphen is designated as one dash, with **no space between the letter and the dash**, e.g. ovate-lanceolate. See also 17.6.

2.11 An N-dash is typed in MS Word code (alt + 0150) or as **three hyphens with no space between the letter and the hyphen**, e.g. 2- -5 mm (typeset, it looks like this, 2–5 mm).

2.12 An M-dash is typed in MS Word code (alt + 0151) or as **two hyphens with no space between the letter and the hyphen**, e.g. computers- -what a blessing! (typeset, it looks like this: computers—what).

2.13 Do not use a double space anywhere between words, after commas, full stops, colons, semicolons or exclamation marks.

2.14 **Use lower case x as times sign, with one space on either side of the x**, e.g. 2 x 3 mm.

2.15 Use **single (not double)** opening and closing quotes, e.g. the so-called 'stiffy' refers to a rigid diskette.

2.16 Keys—put only three leader dots before number of taxon (with one space before and after each dot), regardless of how far or near the word is from the right margin, e.g. . . . 1. *R. ovata* (see 13.18).

### 3 Requirements for diskettes/stiffies

(text to be submitted only with final/accepted version)

#### 3.1 USE NORMAL STYLE ONLY.

3.2 Electronic files can be provided on 1.4 MB stiffie disks, Iomega zip diskettes, 640 MB optical disks for Apple Mac or on CD.

3.3 Data must be IBM compatible and written in **ASCII, or in Word 97 for Windows 95/98. An rtf file is preferable because it retains the formatting.**

3.4 All lines, headings, keys, etc., should start flush at the margin, therefore **NO INDENTATIONS, FOOTNOTES, TABS OR STYLES** of any kind.

3.5 In MS Word, italics and bold should be used where necessary.

3.6 Paragraphs and headings are delineated by a carriage return (ENTER) but **no indentation.**

3.7 **Graphics i.e. drawings, graphs or photographs: submit in a separate file, must not be included in the text.**

3.8 Image files with a bigger file size than 1MB cannot be e-mailed as the NBI has a 1MB limitation on the network's firewall at Head Office.

3.9 If any image file was originated in CorelDraw versions 3–9, please provide the image file as a CDR file (please include fonts). The conversion to TIF or other file extensions will be accommodated by the NBI (see 12.2, 12.3).

3.10 If extensive changes to image files are proposed by the editor, the author will be contacted and the specific image file will have to be re-submitted after the indicated corrections have been implemented.

#### 4 Author(s)

When there are several authors, the covering letter should indicate clearly which of them is responsible for correspondence and, if possible, telephonically available while the article is being processed. The contact address and telephone number should be mentioned if they differ from those given on the letterhead.

#### 5 Title

The title should be as concise and as informative as possible. In articles dealing with taxonomy or closely related subjects, the family of the taxon under discussion (see also 13.2) should be mentioned in brackets but **author citations should be omitted from plant names** (see also 13.6).

#### 6 Keywords

Up to 10 keywords (or index terms) should be provided in English in **alphabetical sequence**. The follow-

ing points should be borne in mind when selecting keywords:

6.1 Keywords should be unambiguous, internationally acceptable words and not recently coined little-known words.

6.2 They should be in a noun form and verbs should be avoided.

6.3 They should not consist of an adjective alone; adjectives should be combined with nouns.

6.4 They should not contain prepositions.

6.5 The singular form should be used for processes and properties, e.g. evaporation.

6.6 The plural form should be used for physical objects, e.g. augers.

6.7 **Location** (province and/or country); taxa (species, genus, family) and vegetation type (community, veld type, biome) should be used as keywords.

6.8 Keywords should be selected hierarchically where possible, e.g. both family and species should be included.

6.9 They should include terms used in the title.

6.10 They should answer the following questions:

6.10.1 What is the *active concept* in the document (activity, operation or process).

6.10.2 What is the *passive concept* or object of the active process (item on which the activity, operation or process takes place).

6.10.3 What is the means of accomplishment or how is the active concept achieved (technique, method, apparatus, operation or process).

6.10.4 What is the environment in which the active concept takes place (medium, location).

6.10.5 What are the independent (controlled) and dependent variables?

6.11 Questions 6.10.1 to 6.10.3 should preferably also be answered in the title.

#### 7 Abstract

7.1 Abstracts of no more than 200 words should be provided. Abstracts are of great importance and should convey the essence of the article.

7.2 They should refer to the geographical area concerned and, in taxonomic articles, mention the number of taxa treated. They should not contain information not appearing in the article.

7.3 In articles dealing with taxonomy or closely related subjects all taxa from the rank of genus downwards should be accompanied by their author citations (see also 13.6).

**7.4 Names of new taxa and new combinations should not be italicized but put in bold.** If the article deals with too many taxa, only the important ones should be mentioned.

## 8 Table of contents

A table of contents should be given for all articles longer than about 60 typed pages, unless they follow the strict format of a taxonomic revision.

## 9 Acknowledgements

Acknowledgements should be kept to the minimum compatible with the requirements of courtesy. Please give all the initials of the person(s) you are thanking.

## 10 Literature references

### *In text*

10.1 Literature references in the text should be cited as follows: 'Jones & Smith (1986) stated...', or '...(Jones & Smith 1986)' or (Ellis 1988: 67) when giving a reference simply as authority for a statement. For treatment of literature references in taxonomic papers see 14.

10.2 When **more than two authors** are involved in the paper, use the name of the first author followed by *et al.*

10.3 When referring to more than one literature reference, they should be arranged **chronologically** and separated by a semicolon, e.g. (Nixon 1940; Davis 1976; Anon. 1981, 1984).

10.4 Titles of books and names of journals should preferably not be mentioned in the text. If there is good reason for doing so, they should be treated as described in 10.12 & 10.13.

10.5 Personal communications are given only in the text, not in the list of references. Please add the person's full initials to identify the person more positively, e.g. C. Boucher pers. comm.

### *In References at end of article*

10.6 References of the same author are arranged in chronological sequence.

10.7 Where two or more references by the same author are listed in succession, the author's name is repeated with every reference, except in an obituary, where the name of the deceased in the list of publications (not in the references) is replaced by an N-dash.

10.8 All publications referred to in the text, including those mentioned in full in the treatment of correct names in taxonomic papers, but no others, and no personal communications, are listed at the end of the manuscript under the heading References.

10.9 The references are arranged alphabetically according to authors and chronologically under each author, with a, b, c, etc. added to the year, if the author has published more than one work in a year. **This sequence is retained when used in the text, irrespective of the chronology.**

10.10 If an author has published both on his own and as a senior author with others, the solo publications are listed first and after that, in strict alphabetical sequence, those published with one or more other authors.

10.11 Author names are typed in capitals.

10.12 Titles of journals and of books are written out in full and are italicized as follows: *Transactions of the Linnean Society of London* 5: 171–217, or *Biology and ecology of weeds*: 24.

10.13 Titles of books should be given as in *Taxonomic literature*, edn 2 by Stafleu & Cowan and names of journals as in the latest edition of *World list of scientific periodicals*.

10.14 Examples of references:

### *Collective book or Flora*

BROWN, N.E. 1909. Asclepiadaceae. In W.T. Thiselton-Dyer, *Flora capensis* 6,2: 518–1036. Reeve, London.

CUNNINGHAM, A.B. 1994. Combining skills: participatory approaches in biodiversity conservation. In B.J. Huntley, Botanical diversity in southern Africa. *Strelitzia* 1: 149–167. National Botanical Institute, Pretoria.

### *Book*

DU TOIT, A.L. 1966. *Geology of South Africa*, edn 3, S.M. Haughton (ed.). Oliver & Boyd, London.

HUTCHINSON, J. 1946. *A botanist in southern Africa*. Gawthorn, London.

### *Journal*

DAVIS, G. 1988. Description of a proteoid-restioid stand in Mesic Mountain Fynbos of the southwestern Cape and some aspects of its ecology. *Bothalia* 18: 279–287.

SMOOK, L. & GIBBS RUSSELL, G.E. 1985. Poaceae. *Memoirs of the Botanical Survey of South Africa* No. 51: 45–70.

STEBBINS, G.L. Jr 1952. Aridity as a stimulus to plant evolution. *American Naturalist* 86: 35–44.

### *In press, in preparation*

TAYLOR, H.C. in press. *A reconnaissance of the vegetation of Rooiberg State Forest*. Technical Bulletin, Department of Forestry.

VOGEL, J.C. 1982. *The age of the the Kuiseb river silt terrace at Homeb. Palaeoecology of Africa* 15. In press.

WEISSER, P.J., GARLAND, J.F. & DREWS, B.K. in prep. Dune advancement 1937–1977 and preliminary vegetation succession chronology at Mlalazi Nature Reserve, Natal, South Africa. *Bothalia*.

### *Thesis*

KRUGER, F.J. 1974. *The physiography and plant communities of the Jakkalsrivier Catchment*. M.Sc. (Forestry) thesis, University of Stellenbosch.

MUNDAY, J. 1980. *The genus Monechma Hochst. (Acanthaceae tribe Justiciae) in southern Africa*. M.Sc. thesis, University of the Witwatersrand, Johannesburg.

### *Miscellaneous paper, report, unpublished article, technical note, congress proceedings*

ANON. no date. *Eetbare plante van die Wolkberg*. Botanical Research Unit, Grahamstown. Unpublished.



BAWDEN, M.G. & CARROL, D.M. 1968. *The land resources of Lesotho*. Land Resources Study No. 3, Land Resources Division, Directorate of Overseas Surveys, Tolworth.

BOUCHER, C. 1981. Contributions of the Botanical Research Institute. In A.E.F. Heydon, *Proceedings of workshop research in Cape estuaries*: 105–107. National Research Institute for Oceanology, CSIR, Stellenbosch.

NATIONAL BUILDING RESEARCH INSTITUTE 1959. *Report of the committee on the protection of building timbers in South Africa against termites, woodboring beetles and fungi*, edn 2. CSIR Research Report No. 169.

## 11 Tables (also digital submissions)

11.1 Each table should be presented on a separate sheet and be assigned an Arabic numeral, i.e. the first table mentioned in the text is marked 'Table 1'.

11.2 In the captions of tables the word 'TABLE' is written in capital letters. See recent numbers of *Bothalia* for the format required.

11.3 Avoid vertical lines, if at all possible. Tables can often be reduced in width by interchanging primary horizontal and vertical heads.

## 12 Figures (also digital submissions)

12.1 Figures should be planned to fit, after reduction, into a width of either 80, 118 or 165 mm, with a maximum vertical length of 230 mm. Allow space for the caption in the case of figures that will occupy a whole page.

12.2 Line drawings, including graphs and diagrams, should be twice the size of the final reproduction and should be in jet-black Indian ink, preferably on fine Schoellers Hammer Parole or similar paper, 200 gsm, or tracing film. **Lines should be bold enough and letters/ symbols large enough to stand reduction. If submitted electronically, provide the drawing as a TIF, BMP or JPG file at 600 dots per inch (dpi) and a hard copy of the figure.**

12.3 Photographs should be of excellent quality on glossy paper with clear detail and moderate contrast, and **they should be the same size as required in the journal. If submitted electronically, provide as a TIF, BMP or JPG file at 300 dpi. Include a hard copy of good quality.**

12.4 Photograph mosaics should be submitted complete, the component photographs mounted neatly on a white **flexible card base (can be curved around drum of scanner)** leaving a narrow gap of uniform width (2 mm) between each print. Note that grouping photographs of markedly divergent contrast results in poor reproductions.

12.5 Lettering on photograph mosaics, **in capital letters**, should be put on a small white disk  $\pm 7$  mm in diameter, if the background is dark, and placed in the **lower left hand corner** of the relevant photo.

12.6 If several illustrations are treated as components of a single composite figure they should be designated by **capital letters**.

12.7 Note that the word 'Figure' should be written out in full, both in the text and the captions and should begin with a capital 'F' (**but see 14.7 for taxonomic papers**).

12.8 In the text the figure reference is then written as in the following example: 'The stamens (Figure 4A, B) are...'

12.9 In captions, 'FIGURE' is written in capital letters. Magnification of figures should be given for the size as submitted.

12.10 **Scale bars or scale lines should be used on figures.**

12.11 In figures accompanying taxonomic papers, voucher specimens should be given in the relevant caption.

12.12 Figures are numbered consecutively with Arabic numerals **in the order they are referred to in the text**. These numbers, as well as the author's name and an indication of the top of the figure, must be written in soft pencil on the back of all figures.

12.13 Captions of figures must not be pasted under the photograph or drawing and must also not be included in any electronic version.

12.14 Authors should indicate **in pencil** in the text where they would like the figures to appear.

12.15 Authors wishing to have the originals of figures returned must inform the editor in the original covering letter and must mark each original 'To be returned to author'.

12.16 Authors wishing to use illustrations already published elsewhere must obtain written permission before submitting the manuscript and inform the editor of this fact.

12.17 Captions for figures should be collected together and typed **at the end of the MS** and headed *Captions for figures*.

12.18 It is strongly recommended that taxonomic articles include dot maps as figures to show the distribution of taxa. The dots used must be large enough to stand reduction to 80 mm (recommended size; 5 mm diameter).

12.19 Blank distribution maps of southern Africa, Africa and the world are available from the Bookshop, NBI Pretoria.

12.20 A dot map PC programme for distribution of taxa in South Africa, called MAPPIT is available for purchase from the Data Section, National Botanical Institute, Pretoria.

## 13 Text

13.1 As a rule, authors should use the plant names (but not of all authors of plant names—see 13.6) as listed in PRECIS (National Herbarium **PRE**toria Computerised Information System).

13.2 Names of genera and infrageneric taxa are usually italicized, with the author citation (where relevant; see 13.6) not italicized. Exceptions include names of new taxa in the abstract, correct names given in the synopsis or in paragraphs on species excluded from a given supraspecific group in taxonomic articles; in checklists and in indices, where the position is reversed, correct names are not italicized and synonyms are italicized.

13.3 Names above generic level are not italicized.

13.4 In articles dealing with taxonomy, the complete scientific name of a plant (with author citation) should be given at the first mention in the text. The generic name should be abbreviated to the initial thereafter, except where intervening references to other genera with the same initial could cause confusion (see 16.6).

**13.5 In normal text, Latin words are italicized, but in the synopsis of a species, Latin words such as *nom.*, *nud.* and *et al.* are not italicized** (see 14.3, 16.4, 17.9).

13.6 In accordance with Garnock-Jones & Webb (1996) in *Taxon* 45: 285, 286, authors of plant names are not to be added to plant names except in taxonomic papers. Names of authors of plant names should agree with the list published by the Royal Botanic Gardens, Kew, entitled, *Authors of plant names*, edited by R.K. Brummitt & C.E. Powell (1992).

13.7 Modern authors not included in the list should use their full name and initials when publishing new plant names. Other author names not in the list should be in agreement with the recommendations of the Code.

13.8 Names of authors of publications are written out in full, without initials, except in the synonymy in taxonomic articles where they are treated like names of authors of plant names.

13.9 Names of plant collectors are italicized whenever they are linked to the number of a specimen. The collection number is also italicized, e.g. *Acocks 14407*.

13.10 Surnames beginning with 'De', 'Du' or 'Van' begin with a capital letter unless preceded by an initial.

13.11 For measurements use only units of the International System of Units (SI). **In taxonomic papers only mm and m, should be used; in ecological papers cm or m should be used.**

13.12 The use of '±' is preferred to c. or ca (see 17.7).

13.13 Numbers 'one' to 'nine' are spelt out in normal text, and from 10 onwards they are written in Arabic numerals.

13.14 In descriptions of plants, numerals are used throughout. Write 2.0–4.5 (not 2–4.5). When counting members write 2 or 3 (not 2–3), but 2–4.

13.15 Abbreviations should be used sparingly but consistently. No full stops are placed after abbreviations ending with the last letter of the full word (e.g. edition = edn; editor = ed.); after units of measure; after compass directions; after herbarium designations; **after countries, e.g. USA and after well-known institutions, e.g. CSIR.**

13.16 Apart from multi-access keys, indented keys should be used with couplets numbered 1a–1b, 2a–2b, etc. (without full stops thereafter).

13.17 Keys consisting of a single couplet have no numbering.

13.18 Manuscripts of keys should be presented as in the following example:

1a Leaves closely arranged on an elongated stem; a submerged aquatic with only the capitula exserted . . . 1b. *E. setaceum* var. *pumilum*

1b Leaves in basal rosettes; stems suppressed; small marsh plants, ruderals or rarely aquatics:

2a Annuals, small, fast-growing pioneers, dying when the habitat dries up; capitula without coarse white setae; receptacles cylindrical:

3a Anthers white . . . 2. *E. cinereum*

3b Anthers black . . . 3. *E. nigrum*

2b Perennials, more robust plants; capitula sparsely to densely covered with short setae:

13.19 Herbarium voucher specimens should be referred to wherever possible, not only in taxonomic articles.

## 14 Species treatment in taxonomic papers

14.1 The procedure to be followed is illustrated in the example (17.9), which should be referred to, because not all steps are described in full detail.

14.2 The correct name (bold, not italicized) is to be followed by its author citation (italicized) and the full literature reference, with the name of the publication written out in full (not italicized).

14.3 Thereafter all literature references, including those of the synonyms, should only reflect author, page and year of publication, e.g. C.E.Hubb. in *Kew Bulletin* 15: 307 (1960); Boris et al.: 14 (1966); Boris: 89 (1967); Sims: t. 38 (1977); Sims: 67 (1980).

14.4 The description and the discussion should consist of paragraphs commencing, where possible, with italicized leader words such as *flowering time*, *etymology*, *diagnostic characters*, *distribution* and *habitat*.

14.5 When more than one species of a given genus is dealt with in a paper, the correct name of each species should be prefixed by a sequential number followed by a full stop. Intraspecific taxa are marked with small letters, e.g. 1b., 12c., etc.

14.6 Names of authors are written as in 13.6, irrespective of whether the person in question is cited as the author of a plant name or of a publication.

14.7 The word 'figure' is written as 'fig.', and 't.' is used for both 'plate' and 'tablet' (but see 12.7 for normal text).

14.8 Literature references providing good illustrations of the species in question may be cited in a paragraph commencing with the word **Illustrations** followed by a colon. This paragraph is given after the last paragraph of the synonymy, see 17.9.

14.9 When new combinations are made, the full literature reference must be given for the basionym, e.g.:



**Antimima saturata** (*L.Bolus*) *H.E.K. Hartmann*, comb. nov.

*Ruschia saturata* L.Bolus in Notes on Mesembrianthemum and allied genera, part 2: 122 (1929). *Mesembryanthemum atrocinctum* N.E.Br.: 32 (1930). Type: *Pillans BOLI8952* (BOL, holo.).

## 15 Citation of specimens

15.1 Type specimen in synopsis: the following should be given (if available): country (if not in RSA), province, grid reference (at least for new taxa), locality as given by original collector, modern equivalent of collecting locality in square brackets (if relevant, e.g. Port Natal [now Durban]), **quarter-degree square**, date of collection (optional), collector's name and collecting number (both italicized).

15.2 The abbreviation s.n. (*sine numero*) is given after the name of a collector who usually assigned numbers to his collections but did not do so in the specimen in question (see 15.11), **or the herbarium number can then be cited with no space between the herbarium and its number e.g. Marloth SAM691 (see 17.9)**. The herbaria in which the relevant type(s) are housed are indicated by means of the abbreviations given in the latest edition of *Index Herbariorum*.

15.3 The holotype (holo.) and its location are mentioned first, followed by a semicolon, the other herbaria are arranged alphabetically, separated by commas.

15.4 Authors should indicate by means of an exclamation mark (!) which of the types have been personally examined.

15.5 If only a photograph or microfiche was seen, write as follows: *Anon.* 422 (X, holo.,—BOL, photo.).

15.6 Lectotypes or neotypes should be chosen for correct names without a holotype. It is not necessary to lectotypify synonyms.

15.7 When a lectotype or a neotype are newly chosen, this should be indicated by using the phrase 'here designated' (see 17.9). If reference is made to a previously selected lectotype or neotype, the name of the designating author and the literature reference should be given. In cases where no type was cited, and none has subsequently been nominated, this may be stated as 'not designated'.

15.8 In brief papers mentioning only a few species and a few cited specimens the specimens should be arranged according to the grid reference system: Provinces/countries (typed in capitals) should be cited in the following order: Namibia, Botswana, Northern Province (previously Northern Transvaal), North-West (previously northeastern Cape and southwestern Transvaal), Gauteng (previously PWV), Mpumalanga (previously Eastern Transvaal), Free State (previously Orange Free State), Swaziland, KwaZulu-Natal (previously Natal), Lesotho, and Northern Cape, Western Cape and Eastern Cape (Figure 1).

15.9 Grid references should be cited in numerical sequence.

15.10 Locality records for specimens should preferably be given to within a quarter-degree square. Records from the same one-degree square are given in alphabetical order, i.e. (—AC) precedes (—AD), etc. Records from the same quarter-degree square are arranged alphabetically

according to the collectors' names; the quarter-degree references must be repeated for each specimen cited.

15.11 The relevant international code of the herbaria in which a collection was seen should be given in brackets after the collection number; the codes are separated by commas. The following example will explain the procedure:

KWAZULU-NATAL.—2731 (Louwsburg): 16 km E of Nongoma, (—DD), *Pelser* 354 (BM, K, PRE); near Dwarsand, *Van der Merwe* 4789 (BOL, M), 2829 (Harrismith); near Groothoek, (—AB), *Smith* 234; Koffiefontein, (—AB), *Taylor* 720 (PRE); Cathedral Peak Forest Station, (—CC), *Marriot* s.n. (KMG); Wilgerfontein, *Roux* 426. Grid ref. unknown: Sterkstroom, *Strydom* 12 (NBG).

15.12 For records from outside southern Africa authors should use degree squares without names, e.g.:

KENYA.—0136: Nairobi plains beyond race course, *Napier* 485.

15.13 Monographs and revisions: in the case of all major works of this nature it is assumed that the author has investigated the relevant material in all major herbaria and that he has provided the specimens seen with determinavit labels. It is assumed further that the author has submitted distribution maps for all relevant taxa and that the distribution has been described briefly in words in the text. Under the heading 'Vouchers' no more than five specimens should be cited, indicating merely the collector and the collector's number (both italicized). Specimens are alphabetically arranged according to collector's name. If more than one specimen by the same collector is cited, they are arranged numerically and separated by a comma. The purpose of the cited specimens is not to indicate distribution but to convey the author's concept of the taxon in question.

15.14 The herbaria in which the specimens are housed are indicated by means of the abbreviation given in the latest edition of *Index Herbariorum*. They are given between brackets, arranged alphabetically and separated by commas behind every specimen as in the following example:

Vouchers: *Arnold* 64 (PRE); *Fisher* 840 (NH, NU, PRE); *Flanagan* 831 (GRA, PRE), 840 (NH, PRE); *Marloth* 4926 (PRE, STE); *Schelte* 6161, 6163, 6405 (BOL); *Schlechter* 4451 (BM, BOL, GRA, K, PRE).

15.15 If long lists of specimens are given, they must be listed together before Acknowledgements under the heading *Specimens examined*. They are arranged alphabetically by the collector's name and then numerically for each collector. The species is indicated in brackets by the number that was assigned to it in the text and any infraspecific taxa by a small letter. If more than one genus is dealt with in a given article, the first species of the first genus mentioned is indicated as 1.1. This is followed by the international herbarium designation. Note that the name of the collector and the collection number are italicized:

*Acocks* 12497 (2.1b) BM, K, PRE; 14724 (1.13a) BOL, K, P. *Archer* 1507 (1.4) BM, G. *Burchell* 2847 (2.8c) MB, K. *Burnan* 2401 (3.3) MO, S. B.L. *Burr* 789 (2.6) B, KMG, STE.

## 16 Synonyms

16.1 In a monograph or a revision covering all of southern Africa, **all synonyms based on types of southern**



**African origin, or used in southern African literature,** should be included.

16.2 Illegitimate names are designated by *nom. illeg.* after the reference, followed by *non* with the author and date, if there is an earlier homonym.

16.3 *Nomina nuda* (*nom. nud.*) and invalidly published names are excluded unless there is a special reason to cite them, for example if they have been used in prominent publications.

16.4 In normal text, Latin words are italicized, but in the synopsis of a species Latin words such as *nom. nud.*, *et al.* are not italicized (see 13.5, 14.3, 17.9).

16.5 Synonyms should be arranged chronologically into groups of nomenclatural synonyms, i.e. synonyms based on the same type, and the groups should be arranged chronologically by basionyms, except for the basionym of the correct name which is dealt with in the paragraph directly after that of the correct name.

16.6 When a generic name is repeated in a given synonymy it should be abbreviated to the initial, except where intervening references to other genera with the same initial could cause confusion (see 13.4).

## 17 Description and example of species treatment

17.1 Descriptions of all taxa of higher plants should, where possible, follow the sequence: Habit; sexuality; underground parts (if relevant). *Indumentum* (if it can be easily described for the whole plant). *Stems/branches*. *Bark*. *Leaves*: arrangement, petiole absent/present, pubescence; blade: shape, size, apex, base, margin; midrib: above/below, texture, colour; petiole; stipules. *Inflorescence*: type, shape, position; bracts/bracteoles, **involucral bracts: inner, outer**. *Flowers*: shape, sex. *Receptacle*. *Calyx*. *Corolla*. *Disc*. *Androecium*. *Gynoecium*. *Fruit*. *Seeds*. **Flowering time**. *Chromosome number* (reference). *Conservation status*. Figure (word written out in full) number.

17.2 As a rule, shape should be given before measurements.

17.3 In general, if an organ has more than one of the parts being described, use the plural, otherwise use the singular, for example, petals of a flower but blade of a leaf.

17.4 Language must be as concise as possible, using participles instead of verbs.

17.5 Dimension ranges should be cited as in 17.9.

17.6 Care must be exercised in the use of dashes and hyphens. A *hyphen* is a short stroke joining two syllables of a word, e.g. ovate-lanceolate or sea-green, with no space between the letter and the stroke. An *N-dash* (*en*) is a longer stroke commonly used instead of the word 'to' between numerals, '2–5 mm long' (do not use it between words but rather use the word 'to', e.g. 'ovate to lanceolate'; it is produced by typing three hyphens next to each other, **or in MS Word the code is alt + 0150**. An *M-dash*

(*em*) is a stroke longer than an N-dash and is used variously, e.g. in front of a subspecific epithet instead of the full species name; it is produced by typing two hyphens next to one another, **or in MS Word the code is alt + 0151**.

17.7 The use of '±' is preferred to c. or ca when describing shape, measurements, dimensions, etc. (see 13.12).

17.8 The **decimal point replaces the comma in all units of measurement**, e.g. leaves 1.0–1.5 mm long.

17.9 Example:

1. **Englerophytum magalismontanum** (Sond.) T.D.Penn. The genera of Sapotaceae: 252 (1991). Type: Gauteng, Magaliesberg, Zeyher 1849 (S, holo.–BOL, photo!).

*Bequaertiodendron magalismontanum* (Sond.) Heine & Hemsl.: 307 (1960); Codd: 72 (1964); Elsdon: 75 (1980).

*Chrysophyllum magalismontanum* Sond.: 721 (1850); Harv.: 812 (1867); Engl.: 434 (1904); Bottmar: 34 (1919). *Zeyherella magalismontana* (Sond.) Aubrév. & Pellegr.: 105 (1958); Justin: 97 (1973).

*Chrysophyllum argyrophyllum* Hiern: 721 (1850); Engl.: 43 (1904). *Boivinella argyrophylla* (Hiern) Aubrév. & Pellegr.: 37 (1958); Justin et al.: 98 (1973). Types: Angola, Welwitsch 4828 (BM!, lecto., here designated; PRE!); Angola, **Welwitsch s.n.** (BM!).

*Chrysophyllum wilmsii* Engl.: 4, t. 16 (1904); Masonet: 77 (1923); Woodson: 244 (1937). *Boivinella wilmsii* (Engl.) Aubrév. & Pellegr.: 39 (1958); Justin: 99 (1973). Type: **without locality and collector** [B, holo.†; K!, P!, lecto., designated by Aubrév. & Pellegr.: 38 (1958), PRE!, S!, W!, Z!].

*Bequaertiodendron fruticosa* De Wild.: 37 (1923), non Bonpl.: 590 (1823); D.Bakker: 167 (1929); H.Fr.: 302 (1938); Davy: 640 (1954); Breytenbach: 117 (1959); Clausen: 720 (1968); Palmer: 34 (1969). Type: Mpumalanga, Tzaneen Dist., **Granville in Herb. Pillans K48625** (K, holo.!, G!, P!, PRE!, S!).

*B. fragrans* auct. non Oldemann: Glover: 149, t. 19 (1915); Henkel: 226 (1934); Stapleton: 6 (1954).

Illustrations: Harv.: 812 (1867); Henkel: t. 84 (1934?); Codd: 73 (1964); Palmer: 35 (1969).

Woody perennial; main branches up to 0.4 m long, erect or decumbent, grey woolly-felted, leafy. *Leaves* linear to oblanceolate, 3–10(–23) × 1.0–1.5(–4.0) mm, obtuse, base broad, half-clasping. *Heads* heterogamous, campanulate, 7–8 × 5 mm, solitary, sessile at tip of axillary shoots; involucre bracts in 5 or 6 series, inner exceeding flowers, tips subopaque, white, very acute. *Receptacle* nearly smooth. *Flowers* ± 23–30, 7–11 male, 16–21 bisexual, yellow, tipped pink. *Achenes* ± 0.75 mm long, elliptic. *Pappus* bristles very many, equalling corolla, scabridulous. **Flowering time: September**. *Chromosome number*: 2n = 22. Figure 23B.

## 18 New taxa

18.1 The name of a new taxon must be accompanied by at least a Latin diagnosis. Authors should not provide full-length Latin descriptions unless they have the required expertise in Latin at their disposal.

18.2 It is recommended that descriptions of new taxa be accompanied by a good illustration (line drawing or photograph) and a distribution map.

### 18.3 Example:

109. *Helichrysum jubilatum* Hilliard, sp. nov., *H. alsinoidei* DC. affinis, sed foliis ellipticis (nec spatulatis), inflorescentiis compositis a foliis non circumcinctis, floribus femineis numero quasi dimidium hermaphroditorum aequantibus (nec capitulis homogamis vel floribus femineis 1–3 tantum) distinguitur.

Herba annua e basi ramosa; caules erecti vel decumbentes, 100–250 mm longi, tenuiter albo-lanati, remote foliati. *Folia* plerumque 8–30 × 5–15 mm, sub capitulis minora, elliptica vel oblanceolata, obtusa vel acuta, mucronata, basi semi-amplexicauli, utrinque cano-lanato-arachnoidea. *Capitula* heterogama, campanulata, 3.5–4.0 × 2.5 mm, pro parte maxima in paniculas cymosas terminales aggregata; capitula subterminalia interdum solitaria vel 2 vel 3 ad apices ramulorum nudorum ad 30 mm longorum. *Bractee involucales* 5-seriatae, gradatae, exteriores pellucidae, pallide stramineae, dorso lanatae, seriebus duabus interioribus subaequalibus et flores quasi aequantibus, apicibus obtusis opacis niveis vix radiantibus. *Receptaculum* fere laeve. *Flores* ± 35–41. *Achenia* 0.75 mm longa, pilis myxogenis praedita. *Pappi* setae multae, corollam aequantes, apicibus scabridis, basibus non cohaerentibus.

TYPE.—Northern Cape, 2817 (Vioolsdrif): Richtersveld, (–CC), ± 5 miles E of Lekkersing on road to Stinkfontein, kloof in hill south of road, annual, disc whitish, 7-11-1962, Nordenstam 1823 (S, holo.; E, NH, PRE).

### 19 New provinces of South Africa (Oct. 1996)

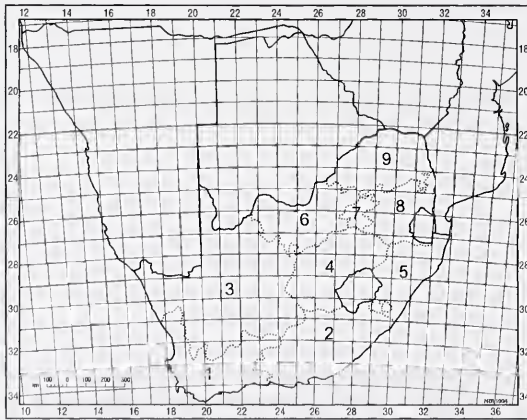


FIGURE 1.—1, Western Cape; 2, Eastern Cape; 3, Northern Cape; 4, Free State (previously Orange Free State); 5, KwaZulu-Natal (previously Natal); 6, North-West (previously northeastern Cape and southwestern Transvaal); 7, Gauteng (previously PWV); 8, Mpumalanga (previously Eastern Transvaal); 9, Northern Province (previously Northern Transvaal).

### 20 Proofs

Only page proofs are normally sent to authors. They should be corrected in red ink and be returned to the editor as soon as possible. Do not add any new information.

### 21 Reprints

Authors receive 100 reprints free. If there is more than one author, this number will have to be shared between them.

### 22 Documents consulted

Guides to authors of the following publications were made use of in the compilation of the present guide: *Annals of the Missouri Botanic Garden*, *Botanical Journal of the Linnean Society*, *Flora of Australia*, *Smithsonian Contributions to Botany*, *South African Journal of Botany* (including instructions to authors of taxonomic papers), *South African Journal of Science*.

### 23 Address of editor

Manuscripts should be submitted to: The Editor, Bothalia, National Botanical Institute, Private Bag X101, Pretoria 0001.

### 24 FSA contributions

24.1 Figures and text must conform to *Bothalia* format.

24.2 These articles will be considered as a full contribution to the *Flora of southern Africa* and will be listed as published in the '*Plan of Flora of southern Africa*', which appears in all issues of the FSA series.

### INDEX

- abbreviation, 13.4, 13.15, 15.2, 15.14, 16.6
- abstract, 2.1, 2.3, 7, 13.2
- acknowledgements, 9
- address of
  - authors, 2.3, 4
  - editor, 23
- alphabetical, 6, 10.9, 10.10, 15.3, 15.10, 15.13, 15.14, 15.15
- Apple Mac, 3.2
- Arabic numerals, 11.1, 12.12, 13.13
- ASCII, 3.3
  - author(s), 1.3, 2.1, 4, 10.14, 12.14–12.16
  - address, 2.3, 4
  - citation, 5, 7.3, 13.2, 13.4, 14.2
  - first, 10.2
  - names, 2.3, 10.2, 10.7, 10.9, 10.11, 12.12, 13.7, 13.8, 14.3, 14.6, 15.7
  - names of plant names, 5, 7.3, 13.1, 13.2, 13.6, 13.7, 13.8, 14.6
  - senior, 10.10
- book reviews, 1.1, 2.4
- books, 10.4, 10.12, 10.13, 10.14
- Bothalia*, 1, 2.2, 11.2, 24.1
- brief taxonomic articles, 15.8
- BRUMMITT, R.K. & POWELL, C.E. (eds) 1992. *Authors of plant names*. Royal Botanic Gardens, Kew, 13.6
- c., 13.12, 17.7
- ca, 13.12, 17.7
- Cape, 15.8, 18.3, 19
- capitals, 11.2, 12.5, 12.6, 12.9, 15.8
- captions, 2.1, 2.4, 2.5, 11.2, 12.7, 12.9, 12.11, 12.13, 12.17
- CD, 3.2
- CDR file, 3.9
- checklist, 13.2
- chromosome number, 17.1, 17.9
- chronological sequence, 10.3, 10.6, 10.9, 16.5
- citation
  - author, 5, 7.3, 13.2, 13.4, 14.2
  - of specimens, 15

- cm, 13.11
- collection
  - date, 15.1
  - number, 13.9, 15.1, 15.2, 15.11, 15.13, 15.15
- collective book, 10.14
- collector, 13.9, 15.1, 15.2, 15.10, 15.13, 15.15
- colon, 2.13, 14.8
- comma, 2.13, 15.3, 15.11, 15.13, 15.14, 17.8
- compass directions, 13.15
- composite figure, 12.6
- Congress proceedings, 10.14
- contents, 8
- CorelDraw 3–9, 3.9
- correspondence, 4
- countries, 6.7, 15.8
- decimal point, 17.8
- description and example of species treatment, 17
- determinavit labels, 15.13
- diagrams, 12.2
- digital submissions of graphics, tables, 11, 12
- discussion, 2.4, 14.4
- diskette, 3, 3.2
- distribution maps, 12.18, 12.19, 12.20, 15.13, 18.2
- documents consulted, 22
- dot maps, 12.18, 12.19, 12.20, 15.13, 18.2
- double
  - line spacing, 2.1
  - space, 2.13, 2.16
- drawing paper, 12.2
- drawings, 3.7, 12.2
- Eastern Transvaal, see Mpumalanga
- edition, 13.15
- editor, 13.15, 23
- editorial
  - board, 1.4
  - policy, 1
- electronic files, 3.2, 3.8–3.10, 12.2, 12.3
- et al.*, 10.2, 13.5, 14.3, 17.9
- example of
  - new taxa, 18.3
  - species treatment, 17.9
- exclamation mark, 2.13, 15.4
- family name, 5, 6.7
- fig., 14.7
- figure(s), 12, 14.7, 17.1
  - digital submissions, 12
  - reduction of, 12.1, 12.2, 12.18
  - returned, 12.15
- file extensions, 3.9, 12.2, 12.3
- firewall, 3.3
- first author, 10.2
- first language, 1.3
- flora, 10.14
- Flora of southern Africa*, 24
- footnote, 2.3, 3.4
- Free State (previously Orange Free State), 15.8, 19
- FSA contributions, 24
- full stop, 2.13, 13.15, 13.16, 14.5
- GARNOCK-JONES, P.J. & WEBB, C.J 1996. The requirement to cite authors of plant names in botanical journals. *Taxon* 45: 285–286. 13.6
- Gauteng (previously PWV), 15.8, 17.9, 19
- genera, 13.2
- generic name, 13.3, 13.4, 16.6
- geographical area, 7.2
- granting agencies, 2.3
- graphics, 3.7
  - digital submissions, 12
- graphs, 3.7, 12.2
- grid reference system, 15.1, 15.8, 15.9, 15.11
- headings, 3.4, 3.6
  - sequence of, 2.3, 2.4
- herbaria, 15.2, 15.3, 15.11, 15.13, 15.14
- herbarium
  - code, 15.11
  - designations, 13.15, 15.15
  - numbers, 15.2
  - voucher specimens, 12.11, 13.19
- here designated, 15.7, 17.9
- holo., 15.3, 15.5, 17.9, 18.3
- holotype, 15.3, 15.6
- homonym, 16.2
- hyphenated words, 2.9
- hyphen, 2.10–2.12, 17.6
- IBM compatible, 3.4
- illegitimate names (nom. illeg.), 16.2
- illustrations, 12.2, 12.6, 12.16, 14.8, 17.9
  - previously published, 12.16
- image files, 3.8–3.10
- indentations, 3.4, 3.6
- Index Herbariorum*, 15.2, 15.14
- index of names, 2.4
- indices, 13.2
- infrageneric taxa, 13.2
- initials, 9, 10.5, 13.7
- in prep., 10.14
- in preparation, 10.14
- in press, 10.14
- International
  - Code of Botanical Nomenclature, 13.7
  - System of Units (SI), 13.11
- invalidly published names, 16.3
- Iomega zip diskette, 3.2
- italics, 7.4, 10.12, 13.2, 13.3, 13.5, 13.9, 14.2, 15.1, 15.13, 15.15
- journals, 10.4, 10.12, 10.14
  - names of, 10.4, 10.13
- justify, 2.8
- keys, 2.16, 3.4, 13.16, 13.17, 13.18
- keywords, 2.3, 2.4, 6
- KwaZulu-Natal (previously Natal), 15.8, 19
- language, 1.3
- Latin, 13.5, 16.4
  - descriptions, 18.1
- layout, 2.2
- lecto., 15.6, 15.7, 17.9
- lectotype, 15.6, 15.7, 17.9
- lettering, 12.5
- line
  - drawings, 2.1, 12.2, 18.2
  - spacing, 2.1
- literature
  - references, 2.1, 10, 10.7, 14.2, 14.3, 14.8, 14.9
  - within synonymy, 14.8
- localities outside southern Africa, 15.12
- locality, 15.1, 15.10
- location, 6.7
- m, 13.11
- magnification of figures, 12.3, 12.9
- manuscript
  - language, 1.3, 17.4
  - requirements, 1.1, 1.2, 1.3, 2
  - sequence, 2.3, 2.4
- map, distribution, dot, 12.18, 12.19, 12.20, 15.13, 18.2, 19
- MAPPIT, 12.20
- M-dash, 2.12, 17.6
- mm, 13.11
- margin, 2.1, 2.16, 3.4, 17.1
- material, 2.3, 2.4
- measurements, 13.11, 17.2, 17.7, 17.8
- methods, 2.4, 6.10.3
- microfiche, 15.5
- miscellaneous paper, 10.14
- monograph, 2.4, 15.13, 16.1
- Mpumalanga (previously Eastern Transvaal), 15.8, 19
- MSWord, 2.7, 2.11, 2.12, 3.5
- name(s)
  - collector's, 15.10
  - illegitimate, 16.2
  - invalidly published, 16.3
  - of author(s), 2.3, 10.2, 10.7, 10.9, 10.11, 12.12, 13.7, 13.8, 14.3, 14.6, 15.7
  - of authors of plant names, 5, 7.3, 13.1, 13.2, 13.6, 13.7, 13.8, 14.6
  - of publications, 13.8
- Natal, see KwaZulu-Natal, 15.8, 19
- N-dash, 2.11, 17.6



- neotype, 15.6, 15.7
- new
  - combinations, 7.4, 14.9
  - provinces of South Africa (Oct. 1996), 15.8, 19
  - taxa, 7.4, 13.2, 13.7, 15.7, 18
- nom. illeg., 16.2
- nom. nud., 13.5, 16.3, 16.4
- non-breaking space, 2.7
- normal style, 3.1
- Northern Province, see Northern Transvaal, 15.8, 19
- North-West, 15.8, 19
- notes, 1, 2.4
  - technical, 10.14
- number
  - chromosome, 17.1, 17.9
  - herbarium, 15.2
- numbering, 13.13
  - figures, 12.12, 17.1
  - keys, 13.16, 13.17
  - pages, 2.5
  - taxa, 14.5, 15.15
- numerals, Arabic, 11.1, 12.12, 13.3
- obituaries, 1.1, 2.4, 10.7
- optical disk, 3.2
- Orange Free State, see Free State, 15.8, 19
- page charges, 1.5
- paragraphs, 3.6
- PC diskettes, 3
- pers. comm., 10.5, 10.8
- personal communications (pers. comm.), 10.5, 10.8
- photocopies, 2.1
- photograph, 3.7, 12.3, 12.4, 12.13, 15.5, 18.2
  - mosaic, 2.1, 12.4, 12.5
- plant
  - collectors, 13.9
  - name, 5, 13.4, 13.6, 13.7, 13.8, 14.6
- plate (t.), 14.7
- PRECIS (National Herbarium **PRE**torian Computerised Information System), 13.1
- prepositions, 6.4
- proceedings, 10.14
- proofs, 20
- provinces, 6.7, 15.1, 15.8
  - of South Africa, 15.8, 19
- publications, 10.8, 13.8, 14.3
  - name of, 14.2
  - solo, 10.10
  - year of, 10.9, 14.3
- PWV, see Gauteng, 15.8, 19
- quarter-degree squares, 15.1, 15.10
- quotes, 2.15
- reduction of figures, 12.1, 12.2, 12.18
- references, 1.4
- reference, 2.4, 10.6, 10.7–10.9, 10.14
  - figure, 12.8
  - grid, 15.1, 15.8, 15.9, 15.11
  - list, 10.5, 10.8, 10.9
  - literature, 2.1, 10
- report, 10.14
- reprints, 21
- requirements for
  - diskette, 3
  - manuscript, 2
- results, 2.4
- revision, 2.4, 8, 15.13, 16.1
- rtf file, 3.3
- scale bar, 12.10
- semicolon, 2.13, 10.3, 15.3, 15.13
- senior author, 10.10
- sequence of headings, 2.3, 2.4
- short notes, 1.1, 2.4
- space
  - double, 2.13
  - non-breaking, 2.7
  - one, 2.16
- special characters, 2.6
- species treatment in taxonomic papers, 14
- specimens examined, 2.4, 15.15
- square brackets, 15.1, 17.9
- STAFLEU, F.A. & COWAN, R.S. 1976–1988. *Taxonomic literature*. Vols 1–7, 10.13
- stiffy/stiffies, 3.2
- style(s), 3.1, 3.4
- submission of MS, 1.2
- surnames, 13.10
- synopsis, 13.2, 13.5, 15.1, 16.4
- synonymy, 13.8, 14.8, 16.6
- t., 14.3, 14.7, 17.9
- table(s), 2.1, 2.4, 2.5, 11
  - digital submissions, 11
  - of contents, 8
- tablet (t.), 14.7
- tabs, 3.4
- taxa
  - name of, 5, 7.4, 10.8, 13.2, 13.3
  - new, 7.4, 13.2, 13.7, 15.7, 18
  - numbering of, 14.5, 15.15
- taxonomic
  - articles/papers, 7.2, 10.8, 12.11, 12.18, 13.2, 13.6, 13.8, 14
  - revision, 8
- taxonomy, 5, 7.3, 13.4
- technical note, 10.14
- text, 2.1, 3.7, 10.1, 10.4, 10.5, 10.8, 10.9, 11.1, 12.7, 12.8, 12.12, 12.14, 13, 15.13, 15.15, 16.4
- thesis, 10.14
- times sign, 2.14
- title, 2.3, 5, 6.9, 6.11
  - of books, 10.4, 10.12, 10.13, 10.14
  - of journals, 10.4, 10.12, 10.13, 10.14
  - page, 2.3, 2.5
- Transvaal, 15.8, 17.9, 19
- type, 15.2, 15.4, 15.7, 16.1, 16.5, 17.9
  - here designated, 15.7, 17.9
  - not designated, 15.7
  - specimen, 15.1
- units of measure, 13.11, 13.15, 17.8
- unpublished article, 10.14
- voucher(s) specimens, 12.11, 13.19, 15.13, 15.4
- Word for Windows, 3.3
- World list of scientific periodicals*, 10.13
- year of publication, 10.9, 14.3

# ANNUAL SUBSCRIPTION

SADC R160,00 Other countries US\$50.00

# TWO-YEAR SUBSCRIPTION

SADC R310,00 Other countries US\$95.00

## BOTHALIA SPECIALS

### Colour plates in Bothalia

Vol. 9, 3 & 4: 27 plates of *Kniphofia* spp. by Cythna Letty and others  
Vol. 16,1: *Kniphofia splendida* by Cythna Letty  
Vol. 27,2: *Nivenia parviflora* by Fay Anderson  
Vol. 28,2: *Cyrtanthus crubescens* by M.E. Connell  
Vol. 29,2: *Gladiolus rhodanthus* by Auriol Batten  
Vol. 30,1: *Clivia miniata* by Barbara Jeppe

### Price per volume

SADC: R30.00 / Other: US\$12.00  
SADC: R10.00 / Other: US\$5.00

SADC: R85.00 / Other: US\$25.00

### Contents to vols 1–20

by H.F. Glen, B.A. Momberg & E. Potgieter (1991)

A brief history of Bothalia; a list of all papers published; a list of all authors, co-authors, keywords and titles; and tables with publication dates, major subjects covered and some information on authors.

**Price:** SADC countries, R15.00 / Other countries US\$7.00

### Contents to vols 21–25

by B.A. Momberg & J.M. Mulvenna (1996)

List of papers alphabetically arranged according to senior author and dates and including all co-authors in alphabetical listing.  
Subject index compiled from keywords and titles, with reference to individual articles.

**Price:** SADC countries, R15.00 / Other countries US\$7.00

### Contents to vols 26–30

by B.A. Momberg (2000)

List of papers alphabetically arranged according to senior author and dates and including all co-authors in alphabetical listing.  
Subject index compiled from keywords and titles, with reference to individual articles.

**Price:** SADC countries, R18.00 / Other countries US\$8.00

### Set of all available issues

up to and including: Volume 30; Contents to Vols 1–20; 21–25; and 26–30; all existing indices.

**Price:** SADC countries, R500.00 / Other countries, US\$200.00

## The history of the Botanical Research Institute

by Denise Fourie

a reprint of this article in *Bothalia* 28,2 with an attractive cover

**Price:** SADC countries, R30.00 / Other countries, US\$10.00

All prices include VAT. Prices are subject to change from time to time. Postage is excluded. Please consult the latest catalogue.

**Available from:** The Bookshop, National Botanical Institute, Private Bag X101, Pretoria 0001, RSA  
Tel. (012) 804-3200 • Fax. (012) 804-3211 • email: bookshop@nbipre.nbi.ac.za

# BOTHALIA

Volume 31.2

Oct. 2001

## CONTENTS

1. Studies in the genus <i>Riccia</i> (Marchantiales) from southern Africa. 25. A new species in subgenus <i>Ricciella</i> , section <i>Ricciella</i> . S.M. PEROLD	151
2. Five new species of <i>Erica</i> (Ericaceae) from the Swartberg Range, Western Cape, South Africa and a note on <i>E. esterhuyseniae</i> . E.G.H. OLIVER and I.M. OLIVER	155
3. Studies in the liverwort family Aneuraceae (Metzgeriales) from southern Africa. 1. The genus <i>Aneura</i> and its local representative. S.M. PEROLD	167
4. Three new species of <i>Tritoniopsis</i> (Iridaceae: Crocoideae) from the Cape Region of South Africa J.C. MANNING and P. GOLDBLATT	175
5. Studies in the liverwort family Aneuraceae (Metzgeriales) from southern Africa. 2. The genus <i>Riccardia</i> and its type species, <i>R. multifida</i> , with confirmation of its presence in the region. S.M. PEROLD	183
6. Notes on African plants:	
Acanthaceae, Thymelaeaceae, Lamiaceae. New records and distributional disjunctions from South Africa, Zimbabwe and Mozambique. T.J. EDWARDS, A.J. BEAUMONT and D. STYLES	199
Colchicaceae. A remarkable new species of <i>Androcymbium</i> from Northern Cape, South Africa. J.C. MANNING and P. GOLDBLATT	203
Dennstaedtiaceae–Pteropsida. <i>Hypolepis villosa-viscida</i> new to the <i>Flora of southern Africa</i> . J.P. ROUX	195
Fabaceae. The identity of <i>Melolobium lampolobum</i> (Papilionoideae) A. MOTEETEE and B-E. VAN WYK	209
Gentianaceae. A new species of <i>Sebaea</i> from the Swartberg Range, Western Cape, South Africa. I.M. OLIVER and J.B.P. BEYERS	207
Hyacinthaceae. The generic delimitation within Hyacinthaceae, a comment on works by F. Speta. B. STEDJE	192
Iridaceae. Two new renosterveld species of Crocoideae from South Africa. J.C. MANNING and P. GOLDBLATT	189
Portulacaceae. <i>Talinum paniculatum</i> , a naturalized weed in South Africa. E.M.A. STEYN and G.F. SMITH	195
Pteridophyta. New distribution records of southern African Pteridophyta. J.E. BURROWS and S.M. BURROWS	205
Zamiaceae. <i>Encephalartos relictus</i> : a new species from southern Africa. P.J.H. HURTER and H.F. GLEN	197
7. Taxonomic significance of inflorescences, floral morphology and anatomy in <i>Passerina</i> (Thymelaeaceae). C.L. BREDENKAMP and A.E. VAN WYK	213
8. Miscellaneous notes:	
Aloaceae. Are ovules and seeds in <i>Lomatophyllum</i> Willd. ( <i>Aloe</i> sect. <i>Lomatophyllum sensu auct.</i> ) anatropous and exarillate? E.M.A. STEYN and G.F. SMITH	237
9. Obituary: Heinrich Johann Wilhelm Giess (1910–2000). HERTA KOLBERG	241
10. Book review	245
11. National Botanical Institute South Africa: administration and research staff, 31 March 2001, publications 1 April 2000–31 March 2001. Compiler: B.A. Momberg	247
12. Guide for authors to <i>Bothalia</i>	265

Abstracted, indexed or listed in • AETFAT Index • AGRICOLA • AGRIS • BIOSIS: *Biological Abstracts/RRM* • CABS • CABACCESS • CAB ABSTRACTS • ISI: *Current Contents*, *Scisearch*, *Research Alert* • *Kew Record of Taxonomic Literature* • *Taxon*: reviews and notices.

ISSN 006 8241

© Published by and obtainable from: National Botanical Institute, Private Bag X101, Pretoria 0001, South Africa. Tel. (012) 804-3200. Fax (012) 804-3211. email: bookshop@nbipre.nbi.ac.za website: www.nbi.ac.za/pubs. Typesetting and page layout: S.S. Brink (NBI). Reproduction: 4 Images, P.O. Box 34059, 0010 Glenstantia, Pretoria. Printing: Africot Printers, P.O. Box 75353, Lynnwood Ridge, 0040 Pretoria. Tel (012) 349-2800/1. Fax (012) 349-2802.